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A COMPLEAT TREATISE OF PRACTICAL NAVIGATION

Demonstrated from it's First

PRINCIPLES:

Together with all the Necessary TABLES.

To which are added,

The Useful *Theorems* of MENSURATION, SURVEYING, and GAUGING; with their Application to Practice.

Written for the Use of the ACADEMY *in* Tower-Street.

By *ARCHIBALD PATOUN*,
Fellow of the Royal Society.

LONDON:

Printed for J. BROTHERTON, J. HAZARD, W. MEADOWS, T. COX, W. HINCHLIFFE, W. BICKERTON, T. ASTLEY, S. AUSTEN, L. GILLIVER, and R. WILLOCK.

M.DCC.XXXIV.

TO

WILLIAM CLELAND, *Esq*;

Of Rayhouse *in the County of* Essex.

SIR,

HAving had the Honour of your Acquaintance for some Time, and considering your Qualifications in this Subject, together with the Obligations I lie under to you, I could not find a more proper Person to patronize this Work: Where-

fore, as a grateful Acknowledgment of the many Favours received, I humbly beg leave to Dedicate this Piece to you; and am with the greatest Regard

SIR,

Your most Obliged

and

most Humble Servant

ARCHIBALD PATOUN.

THE

PREFACE.

HERE are so many Books of Navigation already extant, that it may seem impertinent to trouble the World with a new One; especially since some good Mathematicians both at home and abroad, and many who were perfect Masters of the Practice, have written on this Subject. The former of these being fond of ingenious Speculations, have generally been too prolix on the Theory, and too short on the practical Part. Whereas the later have in a great Measure neglected the Theory, and not being very solicitous about Language or Method, have delivered the practical Rules in such a Manner, as they cannot be easily comprehended, and much less remembred, especially since there is seldom mention made of the Reasons on which they depend.

But I am very far from finding fault with all the Books on this Subject; for there are some very full both on Theory and Practice, against which, I have no other Objection but that they are too tedious to be taught, and too dear to be purchased by most People.

Youth

Youth ought to learn the Elements from shorter Treatises, and afterwards at their leisure should read general Systems, in order to perfect them.

For these Reasons, I have ventured to publish this small Treatise; wherein I have made it my chief Business to keep a due Medium betwixt the two Extremes, into which the speculative Writers on the one Hand, and the practical ones on the other are apt to run. I have laid down all the useful Rules, and troubled the Reader with no more of the Theory than is necessary to explain them. I have also explained the principles of Mensuration, Surveying, aud Gauging, and shewed how they are applied to Practice, in order that my Book might better answer the particular end for which it is designed, namely the Instruction of the young Gentlemen of Mr WATTS's Academy.

As for the particular Contents of each Section, the Reader will find them at the end of the Book, and therefore they need not be repeated here. I shall only observe, that I have designedly omitted Great Circle Sailing, *as being only speculative, and depending on* Spherical Trigonometry, *which would require a particular Volume to explain it. There are indeed two or three Problems necessary in Practice, which depend on the Resolution of Spherical Triangles; but for the Solution of these, I have laid down such clear and short Rules that no body can mistake the manner of applying them.*

I know, some are of Opinion, that the Demonstrations are not to be easily learnt by every Capacity, on which account they teach the Practice only. This Book is therefore so written as to serve for their purpose likewise, because they may take the Rules alone without their Reasons. It is true indeed, that there may be great Difficulty in finding out a proper Demonstration; but after it is found, it is easier to be understood than that of which it is the Reason: and therefore they who are not capable of understanding the Demonstrations, are much less capable of understanding the Practical Rules which depend on them.

them. And I am inclined to believe, that what is commonly attributed to want of Genius in the Scholar, is often owing to want of Method and Perspicuity in the Master.

In preparing this Treatise for the Press, I own myself obliged to Mr Stirling, F. R. S. (*of the Academy in* Tower-Street) *who on his first seeing my Papers, so far approved both of the Matter they contained and of the Order in which they were put together, as to think them fit to be made publick with very little Alteration.*

I acknowledge myself also obliged to that most excellent Book of Mr Hodgson, *entituled a* System of Mathematicks, *which I take to be by far the most compleat Treatise on this Subject, both as to Theory and Practice. And on this occasion I cannot but take notice of a late Writer, who has accused him and all Writers on* Navi-

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" ridional Distance, and Departure; and let him
" see, that tho' these are synonymous Terms in
" Plain Sailing, constantly signifying the same
" thing, and in every Question are represented by
" the same Right Line, yet in the true Sailing they
" are essentially different one from another; and
" and in the same Problem, are, as they really
" should be, represented or expressed by different
" Lines, and are of different Values.

Now

Now after reading this Passage, I shall leave it to the Publick to judge as they think fit of the Writer, who owns that he has seen Mr HODGSON's System of Mathematicks *by his quoting it, and at the same time affirms that he never met with an Author who made any Distinction between Departure and Meridional Distance.*

And I hope I may be excused for vindicating the Author to whom I have professed myself so much obliged, lest, from my Silence on this Head, it should be suspected that I were guilty of the same Error which is unjustly laid to his Charge.

THE

THE PRINCIPLES OF NAVIGATION.

DEFINITION.

AVIGATION is that Art whereby we are enabled to carry a Ship from one Port to another.

This Science depends upon ſome Parts of the Mathematics, which muſt be known before we can treat of it; therefore we ſhall firſt lay down the Principles of *Geometry*.

SECT. I.

Of such Geometrical Propositions as are absolutely necessary for NAVIGATION.

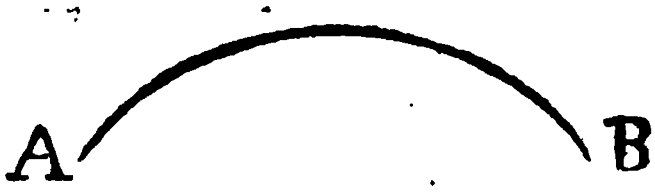
ART. I. GEOMETRY is that Science wherein we consider the Properties of *Magnitude.*

2. A Point is that which is not made up of Parts, or which is of itself indivisible, as A •

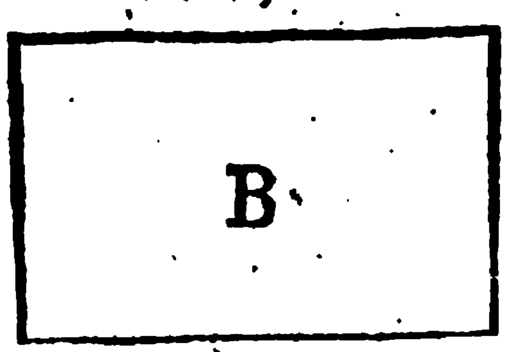
3. A Line is a Length without Breadth, as B——

4. The Extremities of a Line are Points; as the Extremities of the Line AB, are the Points A and B.

5. If the Line AB be the nearest Distance between its Extreams A and B, then it is call'd a strait Line, as AB in the former Figure; but if it be not the nearest Distance, then it is called a curve Line, as A B.



6. A Surface is that which is considered as having only Length and Breadth, but no Thickness, as B.

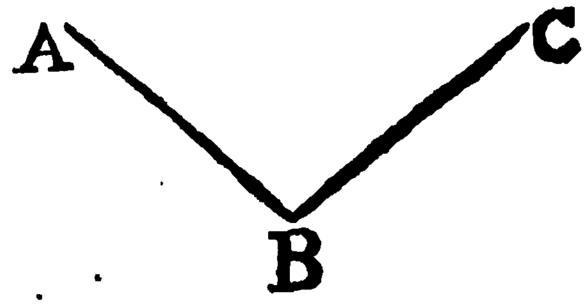


7. The Terms of a Surface are Lines.

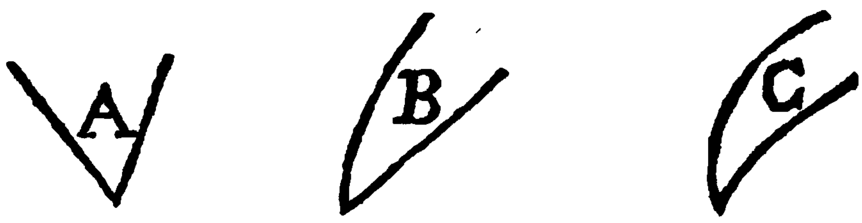
8. A plain Surface is that which lies equally between its Extremes.

9. The Inclination between two Lines meeting one another, (provided they do not make one continued

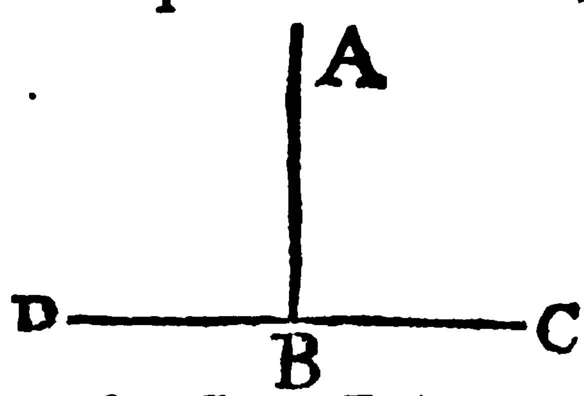
tinued Line) or the Opening between them, is called an Angle; thus the Inclination of the Line AB to the Line CB, meeting one another at B, or the Opening between the two Lines AB and CB, is called an Angle.



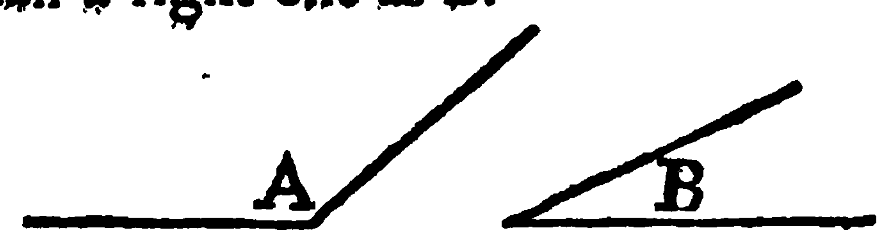
10. When the Lines forming the Angle are right Lines, then it is called a right lin'd Angle, as A; if one of them be right and the other curv'd, it is called a mix'd Angle, as B; if both of them be curv'd, it is called a curve lin'd Angle, as C.



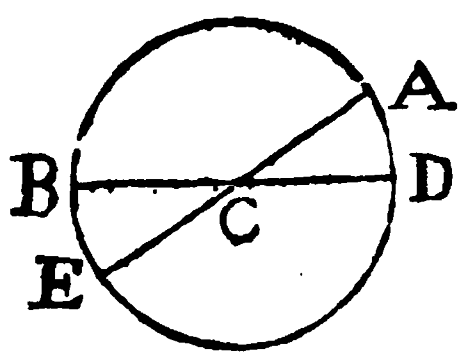
11. If a right Line, AB, fall upon another DC, ſo as to incline neither to the one ſide nor to the other, but make the Angles ABD, ABC on each ſide equal to one another, then the Line AB is ſaid to be perpendicular to the Line DC; and the two Angles are called Right Angles.



12. An obtuſe Angle is that which is greater than a right one, as A; and an acute Angle, that which is leſs than a right one as B.



13. If a right Line DC be faſtened at one of its Ends C, and the other End D, be carried quite round, then the Space comprehended is called a *Circle*; the curve Line deſcribed by the Point D, is called the *Perifery* or *Circumference* of the



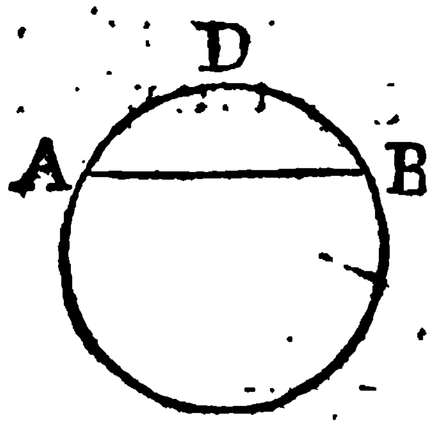
Circle; the fix'd Point C is called the *Center* of it.

14. The describing Line, CD, is called the Radius, *viz.* any Line drawn from the Center to the Circumference; whence all Radii of the same or equal Circles are equal.

15. Any Line drawn through the Center, and terminated both ways by the Circumference, is called a *Diameter*, as BD is a Diameter of the Circle BADE. And the Diameter divides the Circle and Circumference into two equal Parts, and is double the Radius.

16. The Circumference of every Circle is supposed to be divided into 360 equal Parts, called *Degrees*; and each Degree is divided into 60 equal Parts, called *Minutes*; and each Minute into 60 equal Parts, called *Seconds*; and these into *Thirds*, *Fourths*, &c. these Parts being greater or less according as the Radius is.

17. Any Part of the Circumference is called an *Arch*, or *Arc*; and is called an Arc of as many Degrees as it contains Parts of the 360, into which the Circumference was divided: Thus if AD (in the former Figure) be the $\frac{1}{8}$ of the Circumference, then the Arc AD is an Arc of 45 Degrees.



18. A Line drawn from one End of an Arc to the other, is called a *Chord*, and is the measure of the Arc; thus the right Line AB is the Chord of the Arc ADB.

19. Any Part of a Circle cut off by a Chord, is called a *Segment*; thus the Space comprehended between the Chord AB and Circumference ADB (which is cut off by the Chord AB) is called a Segment. Whence it is plain,

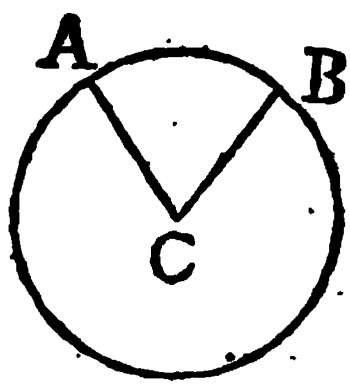
1*st*,

1st, That all Chords divide the Circle into two Segments.

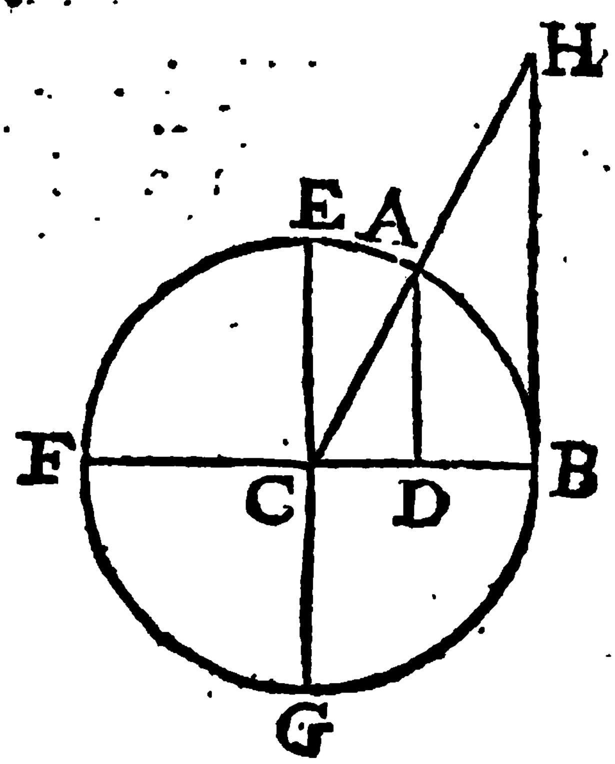
2dly, The less the Chord is the more unequal are the Segments, *&* *e contra.*

3dly, When the Chord is greatest, *viz.* when it is a Diameter, then the Segments are equal, *viz.* each a Semicircle.

20. Any Part of a Circle (less than a Semicircle) contained between two Radii and an Arc, is called a *Sector*; thus the Space contained between the two Radii, AC, BC, and the Arch AB, is called a Sector.



21. The right Sine of any Arc, is a Line drawn perpendicular from one end of the Arc; to a Diameter drawn through the other end of the same Arc; thus AD is the right Sine of the Arc AB, it being a Line drawn from A, the one end of the Arc AB, perpendicular to CB, a Diameter passing through B, the other end of the Arc AB.



Now the Sines standing on the same Diameter still encreafe till they come to the Center, and then becoming the Radius, it is plain that the Radius EC is the greatest possible Sine, and for that reason it is called the *whole-Sine.*

Since the whole Sine EC must be perpendicular to the Diameter FB (by *Def.* 21.) therefore producing the Diameter EG, the two Diameters, FB, EG, must cross one another at right Angles, and so the Circumference of the Circle must be divided by them into four parts EB, BG, GF, and FE, and

these

these four parts are equal to one another (by *Def.* 11.) and so EB a Quadrant, or fourth part of the Circumference; therefore the Radius EC is always the Sine of the Quadrant, or fourth part of the Circle EB.

Sines are said to be of so many Degrees, as the Arch contains parts of the 360, into which the Circumference is supposed to be divided; so the Radius being the Sine of a Quadrant, or fourth part of the Circumference, which contains 90 Degrees; (the fourth part of 360) therefore the Radius must be the Sine of 90 Degrees.

22. That part of the Radius comprehended between the Extremity of the right Sine and the lower End of the Arch, *viz.* DB, is called the versed Sine of the Arch AB.

23. If to any Point in the Circumference, *viz.* B, there be drawn a Diameter FCB, and from the point B perpendicular to that Diameter, there be drawn the Line BH; that Line is called a *Tangent* to the Circle in the point B; which Tangent can touch the Circle only in one point B, else if it touch'd it in more, it would go within it, and so not be a Tangent but a Chord (by *Art.* 18.)

24. The Tangent of any Arch AB, is a right Line drawn perpendicular to a Diameter through the one end of the Arch B, and terminated by a Line CAH, drawn from the Center through the other end A; thus BH is the Tangent of the Arch AB.

25. And the Line which terminates the Tangent, *viz.* CH, is called the Secant of the Arch AB.

26. What an Arch wants of a Quadrant is called the *Complement* of that Arch; thus AE being what the Arch AB wants of the Quadrant EB; is called the Complement of the Arch AB.

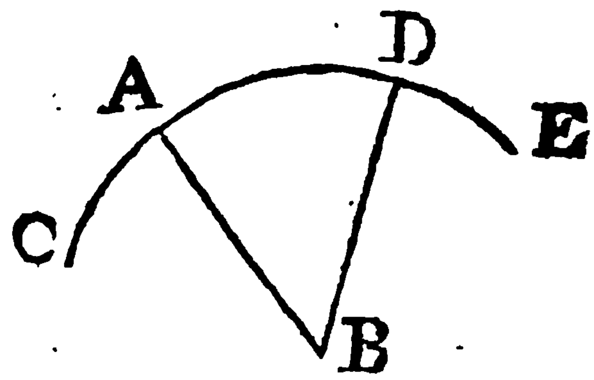
27. And what an Arch wants of a Semicircle is called the *Supplement* of that Arch; thus since AF is

is what the Arch AB wants of the Semicircle BAF, it is called the Supplement of the Arch AB.

28. The Sine, Tangent, *&c.* of the Complement of any Arch, is called the Co-Sine, Co-Tangent, *&c.* of that Arch; thus the Sine, Tangent, *&c.* of the Arch AE is called the Co-Sine, Co-Tangent, *&c.* of the Arch AB.

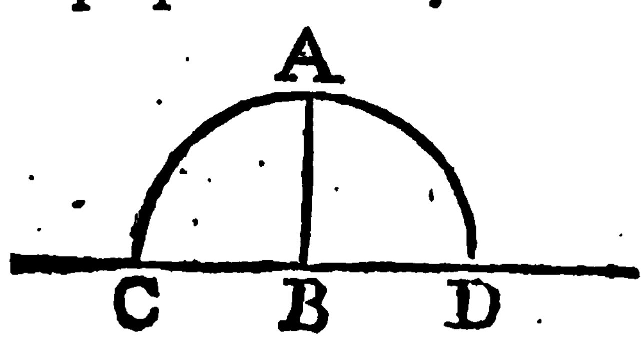
29. The Sine of the Supplement of an Arch is the same with the Sine of the Arch itself, for drawing them according to the Definitions, there results the self same Line.

30. A right lin'd Angle is measured by an Arch of a Circle described upon the angular Point as a Center, comprehended between the two Legs that form the Angle; thus the Angle ABD is measured by the Arch AD of the Circle CADE that is described upon the point B as a Center; and the Angle is said to be of as many Degrees as the Arch is; so if the Arch AD be 45 Degrees, then the Angle ABD is said to be an Angle of 45 Degrees.



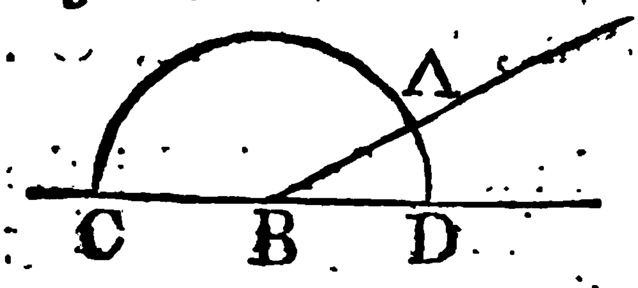
Hence Angles are greater or less according as the Arch described about the angular Point, and terminated by the two Legs, contain a greater or less Number of Degrees.

31. When one Line falls perpendicularly on another, (as AB on CD) then the Angles are right; (by the 11th) and describing a Circle on the Center B, since the Angles ABC, ABD are equal, their measures must be so too, *i. e.* the Arches AC, AD must be equal; but the whole CAD is a Semicircle



micircle, since CD, a Line passing through the Center B, is a Diameter, therefore each of the parts AC, AD is a Quadrant, *i.e.* 90 Degrees; so the measure of a right Angle is always 90 Degrees.

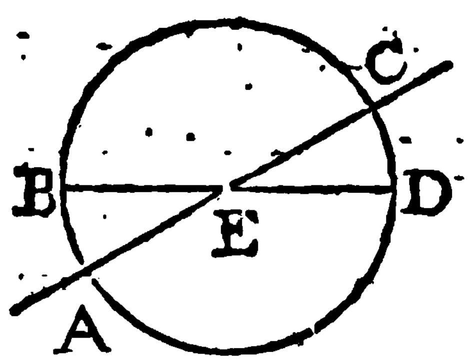
32. If one Line AB fall any way upon another, CD, then the Sum of the two Angles ABC, ABD is always equal to the Sum of two right Angles. For on the point B, describing the Circle CAD, it is plain, that CAD is a Semicircle (by 15th); but CAD is equal to CA and AD the measures of the two Angles; therefore the Sum of the two Angles is equal to a Semicircle, that is, to two right Angles (by the last).



Cor. 1. From whence it is plain, that all the Angles which can be made from a point in any Line, towards one side of the Line, are equal to two right Angles.

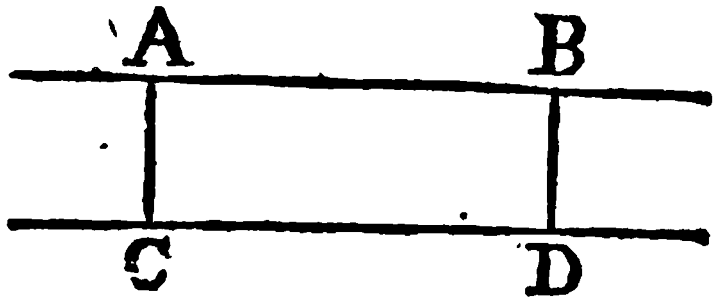
2. And that all the Angles which can be made about a Point, are equal to four right ones.

33. If one Line AC cross another BD in the Point E, then the opposite Angles are equal, *viz.* BEA to CED, and BEC equal to AED. For upon the point E, as a Center, describing the Circle ABCD, it is plain ABC is a Semicircle, as also BCD (by 15th) therefore the Arch ABC is equal to the Arch BCD; and from both taking the common Arch BC, there will remain AB equal to CD, *i.e.* the Angle BEA equal to the Angle CED (by *Art.* 30.). After the same manner we may prove, that the Angle BEC is equal to the Angle AED.



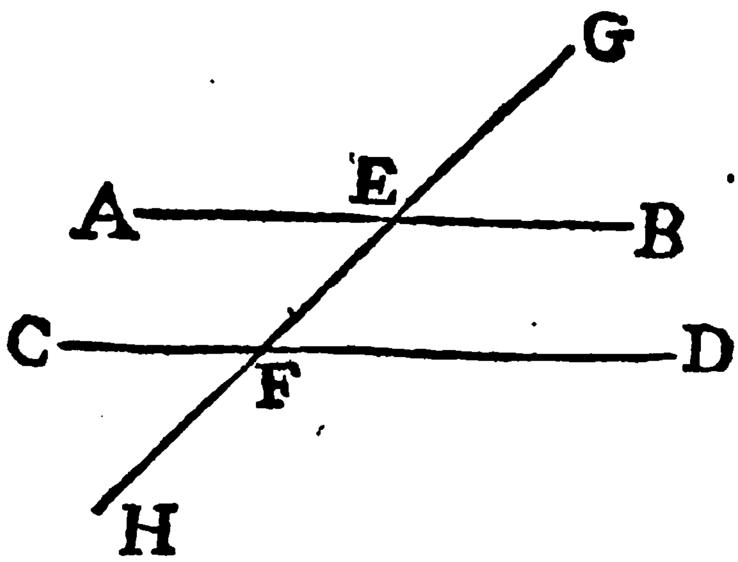
34. Lines

34. Lines which are equally distant from one another are called *Parallel Lines*; as AB, CD.



35. If a Line GH cross two Parallels AB, CD, then the external Angles are equal, *viz.* GEB equal to CFH and AEG equal to HFD. For since AB and CD are parallel to one another, they may be considered as one broad Line, and GH crossing it; then the vertical or opposite Angles GEB, CFH are equal (by the 33d) as also AEG and HFD by the same.

36. If a Line GH cross two Parallels AB, CD then the alternate Angles, *viz.* AEF and EFD, or CFE and FEB are equal; that is, the Angle AEF is equal to the Angle EFD, and the Angle CFE is equal to the Angle FEB, for

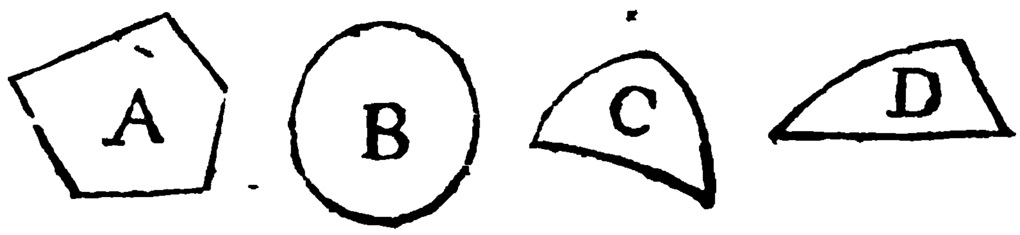


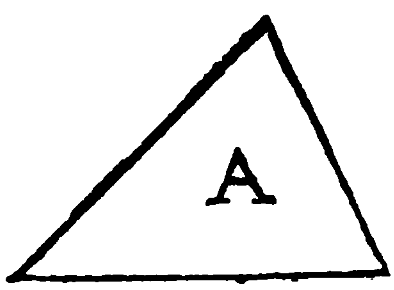
GEB is equal to AEF (by the 33d.) and CFH is equal to EFD by the same, but GEB is equal to CFH by the last. Therefore AEF is equal to EFD; the same way we may prove FEB equal to EFC.

37. If a Line GH cross two parallel Lines AB, CD, then the external Angle GEB is equal to the internal opposite one EFD, or GEA equal to CFE. For the Angle AEF is equal to the Angle EFD by the last; but AEF is equal GEB (by the 33d) therefore GEB is equal to EFD; the same way we may prove AEG equal to CFE.

38. If a Line GH cross two parallel Lines AB, CD, then the Sum of the two internal Angles, *viz.* BEF and DFE, or AEF and CFE are equal to two right Angles; for since the Angle GEB is equal to the Angle EFD (by the last) to both add the Angle FEB, then GEB and BEF are equal to BEF and DFE; but GEB and BEF are equal to two right Angles (by the 32d) therefore BEF and DFE are also equal to two right Angles. The same way we may prove that AEF and CFE are equal in two right Angles.

39. A Figure is any part of Space bounded by Lines or a Line. If the bounding Lines be streight, it is called a *Rectilineal Figure* as A; if they be curved, it is called a curvilineal Figure as B or C; if they be partly curve Lines and partly streight, it is called a *mixt Figure* as D.





40. The most simple rectilineal Figure is that which is bounded by three right Lines, and is called a *Triangle*, as A.

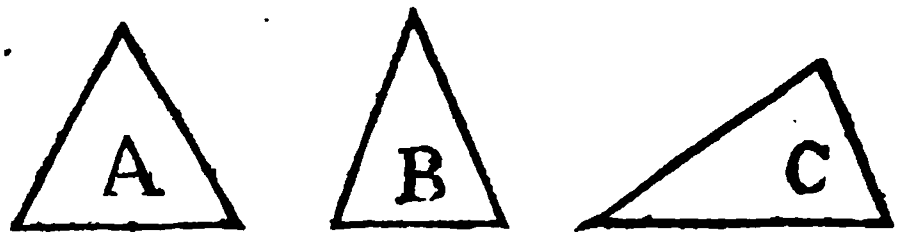
41. Triangles are divided into different kinds, both with respect to their Sides and Angles: with respect to their Sides they are commonly divided into three kinds, *viz.*

42. A Triangle having all it's three Sides equal to one another, is called an *Equilateral Triangle*, as A.

43. A Triangle having two of it's Sides equal to one another, and the third Side not equal to either of them, is called an *Isosceles Triangle*, as B.

44. A Triangle having none of it's Sides equal to one another, is called a *Scalene Triangle*, as C.

45. Tri-

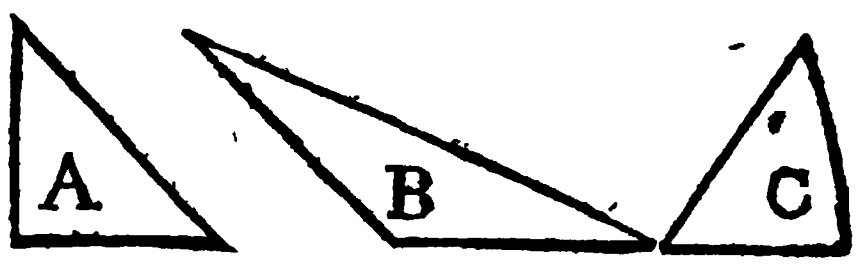


45. Triangles, with respect to their Angles, are divided into three different kinds, *viz.*

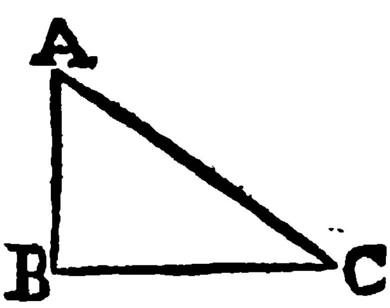
46. A Triangle having one of it's Angles right, is called a *Right-Angled-Triangle*, as A.

47. A Triangle having one of it's Angles obtuse, or greater than a right Angle, is called an *Obtuse-Angled-Triangle*, as B.

48. Lastly, a Triangle having all it's Angles acute, is called an *Acute-Angled-Triangle*, as C.

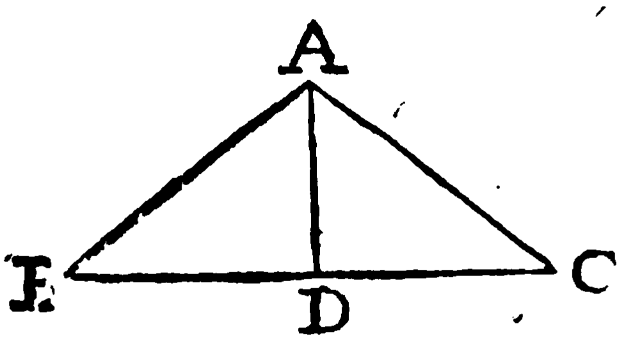


49. In all right angled Triangles, the Sides comprehending the right Angle are called the Legs, and the Side opposite to the right Angle is called the *Hypothenuse*. Thus in the right angled Triangle ABC (the right Angle being at B) the two Sides AB and BC which comprehend the right Angle ABC, are the Legs of the Triangle, and the Side AC, which is opposite to the right Angle ABC, is the Hypothenuse of the right-angled-Triangle ABC.

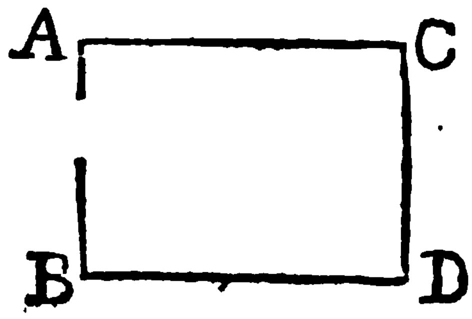


50. Both obtuse and acute angled Triangles are in general called *Oblique-Angled-Triangles*; in all which any Side is called the *Base*, and the other two the Sides.

51. The perpendicular Height of any Triangle is a Line drawn from the Vertex to the Base perpendicularly; thus if the Triangle ABC be proposed, and BC be made it's Base, then A will be the Vertex, *viz.* The Angle opposite to the Base; and if from A you draw the Line AD perpendicular to BC, then the Line AD is the Height of the Triangle ABC standing on BC as it's Base.



Hence all Triangles standing between the same Parallels have the same Height, since all the Perpendiculars are equal by the Nature of Parallels.



52. A Figure bounded by four Sides is called a *Quadrilateral* or *Quadrangular Figure*, as ABDC.

53. Quadrilateral Figures whose opposite Sides are parallel, are called *Parallelograms*. Thus in the quadrilateral Figure ABDC, if the Side AC be parallel to the Side BD which is opposite to it, and AB be parallel to CD, then the Figure ABDC is called a Parallelogram.

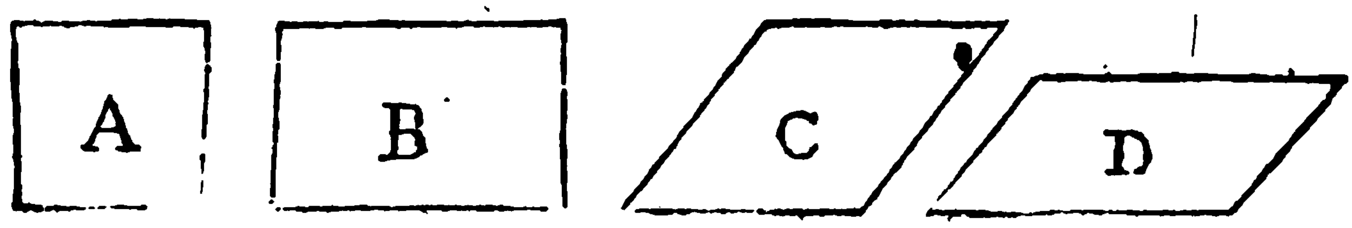
54. A Parallelogram having all it's Sides equal and Angles right, is called a *Square*; as A.

55. That which hath only the opposite Sides equal and it's Angles right, is called a *Rectangle*; as B.

56. That which hath equal Sides but oblique Angles, is called a *Rombus*, as C; and is just an inclin'd Square.

57. That

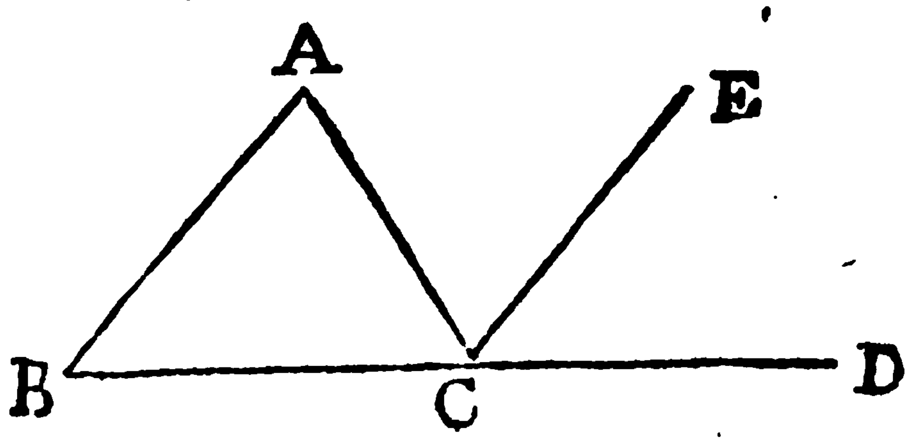
57. That which hath only the opposite Sides equal and the Angles oblique, is called a *Romboides*, as D; and may be conceived as an inclined Rectangle.



58. When none of the Sides are parallel to another, then the quadrilateral Figure is called a *Trapezium*.

59. Every other right-lined Figure, that has more Sides than four is in general called a *Polygon*. And Figures are called by particular Names according to the number of their Sides, *viz.* One of five Sides is called a *Pentagon*, of six a *Hexagon*, of seven a *Heptagon*, and so on. When the Sides forming the Polygon are equal to one another, the Figure is called a regular Figure or Polygon.

60. In any Triangle A B C, one of it's Legs, as B C, being produced towards D, the external Angle A C D is equal to both the internal opposite ones taken together, *viz.* to A B C and B A C. In order to prove this, through C draw C E parallel to A B; then since C E is parallel to A B and A C crosseth them, the Angle E C D is equal to A B C (by the 37th) and the Angle ACE equal to C A B (by the 36th) therefore the Angles E C D and E C A are equal to the Angles A B C and C A B; but the Angles ECD and E C A are together equal to the Angle A C D; therefore the Angle A C D is equal to both the Angles A B C and C A B taken together.



60. In

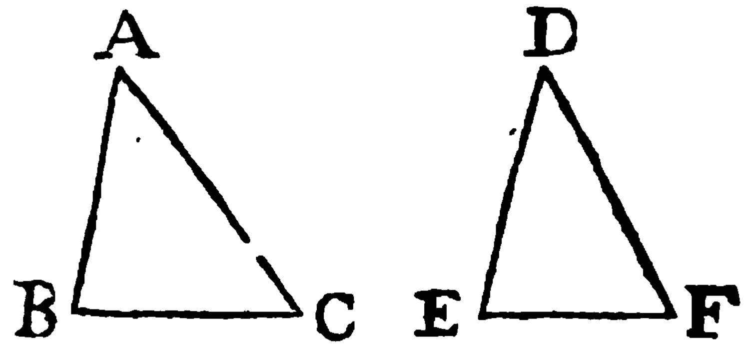
61. In any Triangle ABC all the three Angles taken together are equal to two right Angles. To prove this you must produce BC, one of it's Legs, to any distance, suppose to D; then by the last Proposition, the external Angle, ACD, is equal to the Sum of the two internal opposite ones CAB and ABC; to both add the Angle ACB, then the Sum of the Angles ACD and ACB will be equal to the Sum of the Angles CAB and CBA and ACB. But the Sum of the Angles ACD and ACB, is equal to two right ones (by the 32d) therefore the Sum of the three Angles CAB and CBA and ACB, is equal to two right Angles; that is, the Sum of the three Angles of any Triangle ACB is equal to two right Angles.

Cor. 1. Hence in any Triangle given, if one of it's Angles be known, the Sum of the other two is also known; for since by the last, the Sum of all the three is equal to two right Angles, or a Semicircle, it is plain, that taking any one of them from a Semicircle or 180 Degrees, the Remainder will be the Sum of the other two. Thus (in the former Triangle ABC) if the Angle ABC be 40 Degrees, by taking 40 from 180 we have 140 Degrees; which is the Sum of the two Angles BAC, ACB, the converse of this is also plain, *viz.* The the Sum of any two Angles of a Triangle being given, the other Angle is also known by taking that Sum from 180 Degrees.

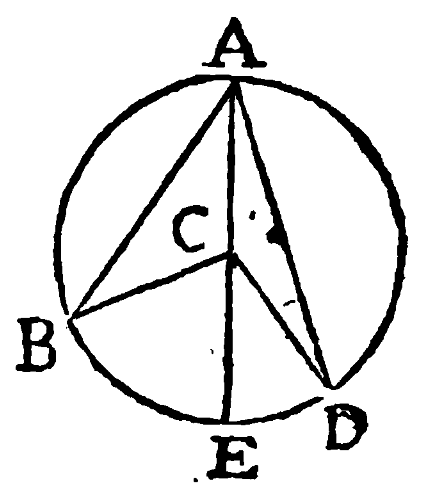
2. In any right angled Triangle, the two acute Angles must just make up a right one between them; consequently, any one of the oblique Angles being given we may find the other by subtracting the given one from 90 Degrees, which is the Sum of both.

to

62. If in any two Triangles, A B C, D E F, two Legs of the one, *viz.* A B and A C, be equal to two Legs in the other, *viz.* to D E and D F, each to each respectively, *i. e.* A B to D E and A C to D F; and if the Angles included between the equal Legs be equal, *viz.* the Angle B A C equal to the Angle E D F; then I say, that the remaining Leg of the one shall be equal to the remaining Leg of the other, *viz.* B C to E F; and the Angles opposite to equal Legs shall be equal, *viz.* A B C equal to D E F (being opposite to the equal Legs A C, and D F) also A C B equal to D F E (which are opposite to the equal Legs A B and D E) for if the Triangle A B C be supposed to be lifted up and put upon the Triangle D E F, and the point A on the point D; it is plain since B A and D E are of equal length, the point E will fall upon the point B; and since the Angles B A C, E D F are equal, the Line AC will fall upon the Line DF, and they being of equal length, the Point C will fall upon the Point F, and so the Line B C will exactly agree with the Line E F, so the Triangle A B C will in all respects be exactly equal to the Triangle D E F; and the Angle A B C will be equal to the Angle D E F, also the Angle A C B will be equal to the Angle D F E.



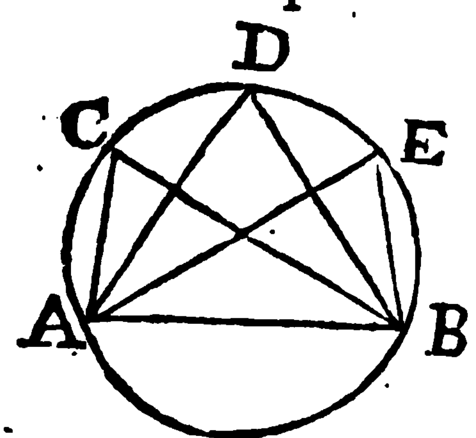
63. Any Angle, as B A D, at the Circumference of a Circle B A D E, is but half the Angle B C D at the Center standing on the same Arch B E D. To demonstrate this, draw through A and the Center C, the right Line A C E, then the Angle E C D is



equal

equal to both the Angles D A C and A D C (by the 60th); but since A C and C D are equal (being two Radii of the same Circle) it is plain the Angles subtended by them must be equal also, *i. e.* the Angle C A D equal to the Angle C D A, therefore the Sum of them is double any one of them, *i. e.* DAC and A D C is double of C A D, and therefore E C D is also double of D A C; the same way it may be proved, that E C B is double of C A B, and therefore the Angle B C D is double of the Angle B A D, or BAD the half of B C D which was to be proved.

Cor. 1. Hence an Angle at the Circumference is measured by half the Arch it subtends, for the Angle at the Center (standing on the same Arch) is measured by the whole Arc (by the 30th); but since the Angle at the Center is double that at the Circumference, it is plain the Angle at the Circumference must be measured by only half the Arch it stands upon.

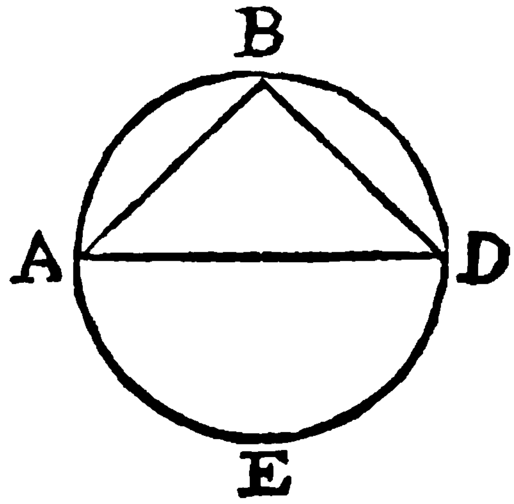


Cor. 2. Hence all Angles, ACB, ADB, AEB, &c. at the circumference of a Circle, standing on the same Chord AB, are equal to one another; for by the last Corollary they are all measured by the same Arc, *viz.* half the Arc A B which each of them subtends.

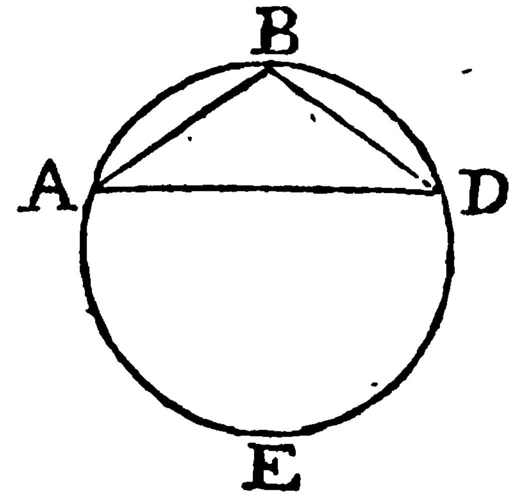
Cor. 3. Hence an Angle in a Segment greater than a Semicircle is less than a right Angle; thus if ADB be a Segment, greater than a Semicircle, (see the last Figure) then the Arch AB, on which it stands, must be less than a Semicircle, and the half of it less than a Quadrant or a right Angle; but the Angle ADB in the Segment, is measured by the half of A B; therefore it is less than a right Angle.

Cor. 4.

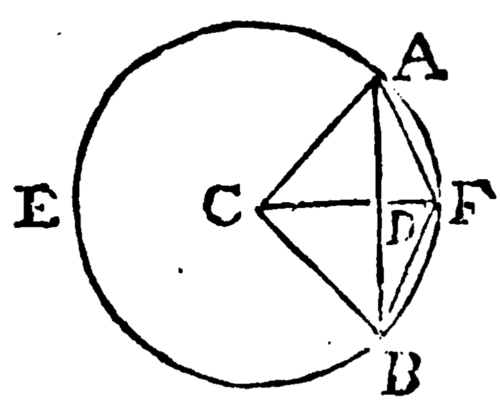
Cor. 4. An Angle in a Semicircle is a right Angle. For since A B D a Semicircle, the Arc A E D must also be a Semicircle; but the Angle ABD is measured by half the Arc A E D, that is, by half a Semicircle or Quadrant; therefore the Angle A B D is a right one.



Cor. 5. Hence an Angle in a Segment less than a Semicircle, as A B D, is greater than a right Angle: for since the Arch A B D is less than a Semicircle, the Arch A E D must be greater than a Semicircle, and so it's half greater than a Quadrant, *i. e.* than the measure of a right Angle; therefore the Angle A B D, which is measured by half the Arch A E D, is greater than a right Angle.



64. If from the Center C of the Circle A B E, there be let fall the Perpendicular C D on the Chord A B, then that Perpendicular will bisect the Chord A B in the Point D. To demonstrate this, draw from the Center to the Extremities of the Chord the two Lines C A, C B; then since the Lines C A and CB are equal, the Angles C A B, C B A, which they subtend must be equal also; but the Perpendicular C D divides the Triangle A C B into two right angled Triangles A C D and C D B, in which the Sum of the Angles A C D and C A D in the one, is equal to the Sum of the Angles D C B and C B D in the other, each being equal to a right Angle, (by *Cor.* 2. of *Art.* 61.) but C A D is equal to C B D, therefore A C D is equal to B C D. So in the two



 Triangles

Triangles A C D and B C D, the two Legs A C and C D in the one are equal to the two Legs B C and C D in the other, each to each respectively, and the included Angles A C D and B C D are equal; therefore the remaining Legs A D and B D are equal (by the 62d) and consequently A B bisected in D.

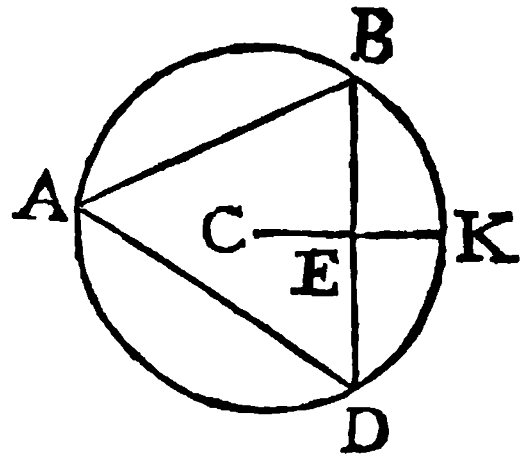
65. If from the Center C of a Circle A B E, there be drawn a Perpendicular C D on the Chord A B, and produced till it meet the Circle in F, then, I say, the Line C F bisects the Arch A B in the Point F; for (see the foregoing Figure) joining the Points A and F, F and B by the streight Lines A F, F B, then in the Triangles A D F, B D F, A D is equal to D B (by the last) and D F common to both; therefore A D and D F two Legs of the Triangle A D F, are equal to B D and D F two Legs of the Triangle B D F, and the included Angles A D F, B D F are equal, being both right; therefore (by the 62d) the remaining Legs A F and F B are equal, but in the same Circle equal Lines are Chords of equal Arches, therefore the Arches A F and F B are equal. So the whole Arch A F B is bisected in the Point F by the Line C F.

Cor. 1. From the 64th it follows, that any Line bisecting a Chord at right Angles is a Diameter; for since (by the 64th) a Line drawn from the Center perpendicular to a Chord bisects that Chord at right Angles, therefore conversly a Line bisecting a Chord at right Angles, must pass thro' the Center and consequently be a Diameter.

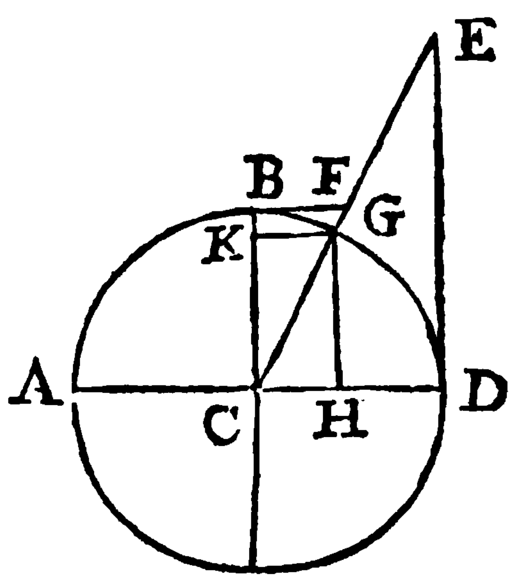
Cor. 2. From the two last it follows, that the Sine of any Arch is the half of the Chord of twice the Arc; for (see the foregoing Scheme) A D is the Sine of the Arc A F, by the Definition of a Sine, and A F is half the Arc A F B, and A D half the Chord A B (by the 64th); therefore the *Cor.* is plain.

66. In any Triangle, the half of each Side is the Sine of the opposite Angle; for if a Circle be suppo-
sed

ſed to be drawn thro' the three angular Points A, B, and D of the Triangle ABD; then the Angle DAB is meaſured by half the Arch BKD (by *Cor.* 1 of *Art.* 63d); but the half of BD, *viz.* BE is the Sine of half the Arch BKD, *viz.* the Sine of BK (by *Cor.* 2. of the laſt) which is the meaſure of the Angle BAD; therefore the half of BD is the Sine of the Angle BAD; the ſame way it may be proved, that the half of AD is the Sine of the Angle ABD, and the half of AB is the Sine of the Angle ADB.



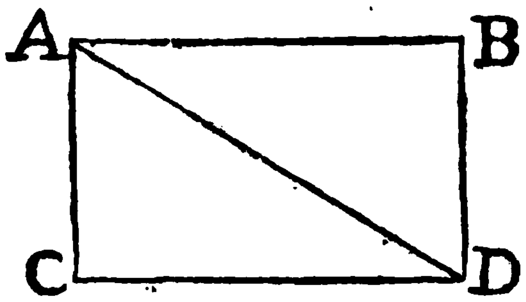
67. The Sine, Tangent, &c. of any Arch is called alſo the Sine, Tangent, &c. of the Angle whoſe meaſure the Arch is; thus becauſe the Arch GD is the meaſure of the Angle GCD, and ſince GH is the Sine, DE the Tangent, HD the verſed Sine, CE the Secant, alſo GK the Co-Sine, BF the Co-Tangent, and CF the Co-Secant, &c. of the Arch GD; then GH is called the Sine, DE the Tangent, &c. of the Angle GCD whoſe meaſure is the Arch GD.



68. If two equal and parallel Lines, AB and CD, be joined by two others, AC and BD; then theſe ſhall alſo be equal and parallel. To demonſtrate this, join the two oppoſite Angles A and D with the Line AD; then it is plain this Line AD divides the Quadrilateral, ACDB, into two Triangles, *viz.* ABD, ACD, in which AB, a Leg of the one, is equal to DC a Leg of the other by Suppoſition, and AD is common to both Triangles; and ſince AB is parallel to CD, the Angle BAD

 will

will be equal to the Angle A D C, (by *Art.* 36.) therefore in the two Triangles, B A, and A D, and the Angle B A D, is equal to C D and D A, and the Angle A D C, that is, two Legs and the included Angle in the one, is equal to two Legs and the included Angle in the other; (by



the 62d) so B D is equal to A C, and the Angle D A C is equal to the Angle A D B, therefore the Lines B D, A C are both equal and parallel.

Cor. 1. Hence it is plain, that the Quadrilateral ABDC is a Parallelogram, since the opposite Sides are Parallel.

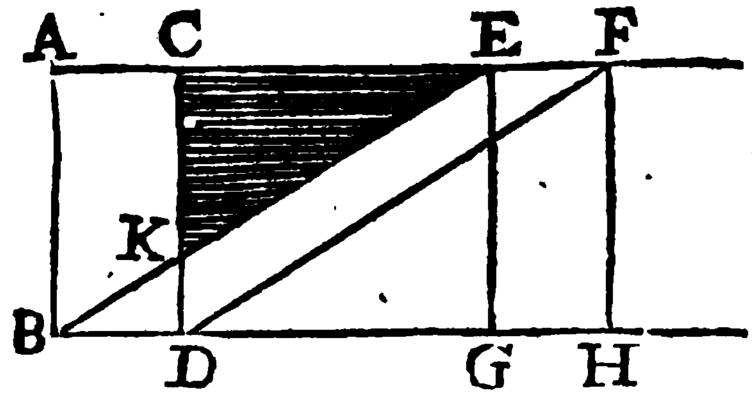
Cor. 2. In any Parallelogram the Line joining the opposite Angles (called the Diagonal) as A D, divides the Figure into two equal parts, since it has been proved that the Triangles A B D, A C D are equal to one another,

Cor. 3. It follows also, that a Triangle A C D on the same Base C D, and between the same parallels with a Parallelogram A B D C, is the half of that Parallelogram.

Cor. 4. Hence it is plain, that the opposite sides of a Parallelogram are equal; for it has been proved that A B D C being a Parallelogram, A B will be equal to C D and A C equal to B D.

69. All Parallelograms on the same or equal Bases, and between the same Parallels, are equal to one another; that is, if B D and G H be equal, and the Lines B H and A F be parallel, then the Parallelograms A B D C, B D F E, and E F H G are equal to one another. For A C is equal to E F each being equal to B D (by *Cor.* 4. of 68.) To both add C E, then AE will be equal to C F. So in the two Triangles A B E, C D F; A B, a Leg of the one, is equal to C D, a Leg in the other; and A E is equal

equal to CF, and the Angle BAE is equal the Angle DCF (by the 37th); therefore the two Triangles ABE, CDF are equal (by the 62d); and taking the Triangle CKE from both, the Figure ABKC will be equal to the Figure KDFE; to both which add the little Triangle KBD, then the Parallelogram ABDC will be equal to the Parallelogram BDFE. The same way it may be proved, that the Parallelogram EFHG is equal to the Parallelogram EFDB; so three Parallelograms ABDC, BDFE, and EFHG will be equal to one another.

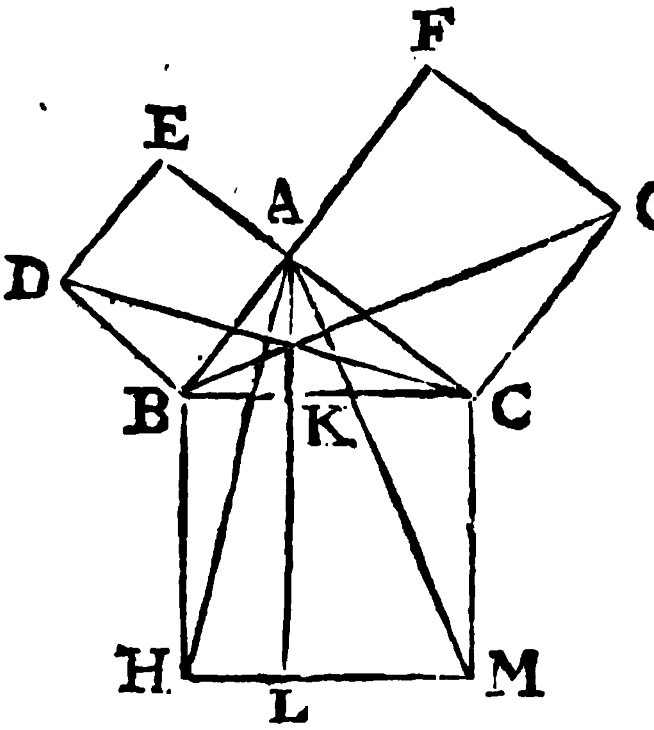


Cor. Hence it is plain, that Triangles on the same Base, and between the same Parallels, are equal; since they are the half of the Parallelograms on the same Base and between the same Parallels.

70. In any right angled Triangle, ABC, the Square of the Hypothenuse BC, *viz.* BCMH is equal to the Sum of the Squares made on the two Sides AB and AC, *viz.* to ABDE and ACGF. To demonstrate this, thro' the Point A draw AKL perpendicular to the Hypothenuse BC, join AH, AM, DC, and BG; then it is plain that DB is equal to BA (by the 54th), also BH is equal to BC (by the same); so in the two Triangles DBC, ABH the two Legs DB and BC in the one, are equal to the two Legs AB and BH in the other; and the included Angles DBC and ABH are also equal; (for DBA is equal to CBH being both right; to both add ABC, then 'tis plain that DBC is equal to ABH) therefore the Triangles DBC, ABH are equal (by the 62d), but the Triangle DBC is half of the Square ABDE (by *Cor.* 3. of 68th) and the Triangle ABH is half the Pallelogram BKLH (by the same), therefore

half

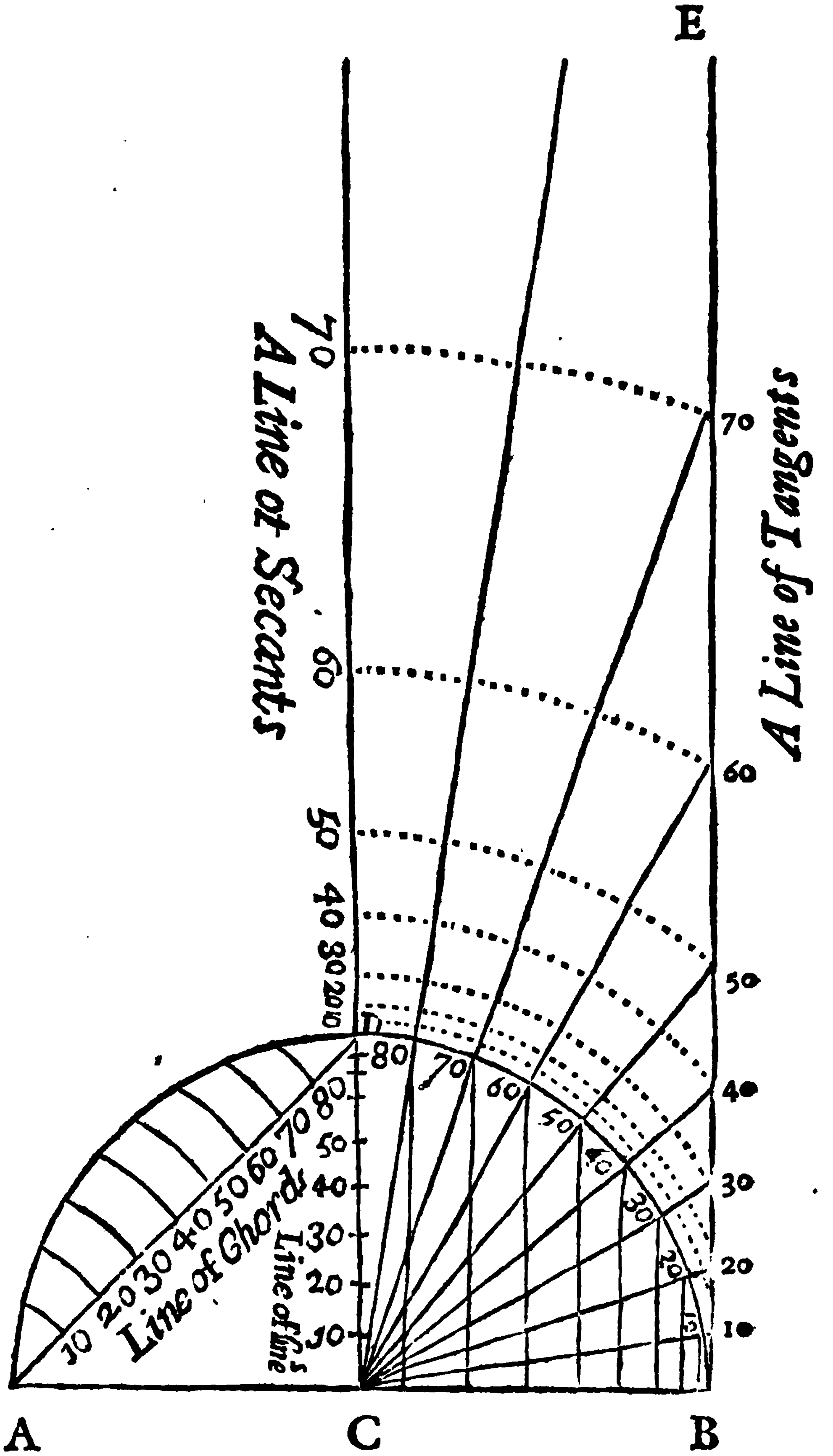
half the Square ABDE is equal to half the Parallelogram BKLH. Consequently the Square ABDE is equal to the Parallelogram BKLH. The same way it may be proved, that the Square ACGF is equal to the Parallelogram KCML. So the Sum of the Squares ABDE and ACGF is equal the Sum of the Parallelograms BKLH and KCML; but the Sum of these Parallelograms is equal to the Square BCMH, therefore the Sum of the Squares on AB and AC is equal to the Square on BC.



Cor. 1. Hence in a rightangled Triangle, the Hypothenuse and one of the Legs being given, we may easily find the other, by taking the Square of the given Leg from the Square of the Hypothenuse, and the square Root of the Remainder will be the Leg required.

Cor. 2. Hence, the Legs in a rightangled Triangle being given, we may find the Hypothenuse, by taking the Sum of the Squares of the given Legs, and extracting the square Root of that Sum.

71 If upon the Line AB there be drawn a Semicircle ADB, whose Center is C, and on the Point C there be raised a Perpendicular to the Line AB, *viz.* CD; then 'tis plain the Arch DB is a Quadrant, or contains 90 Degrees; suppose the Arch DB to be divided into 9 equal Arches, each of which will contain 10 Degrees, then on the Point B raising BE perpendicular to the Line AB, it will be a Tangent to the Circle in the Point B, and if to every one of the Divisions of the Quadrant, *viz.* B 10, B 20, B 30, B 40, *&c.* you draw the Sine, Tangent,



gent, &c. (as in the Scheme) we shall have the Sine, Tangent, &c. to every ten Degrees in the Quadrant; and the same way we may have the Sine, Tangent, &c. to every single Degree in the Quadrant,

Quadrant, by dividing it into 90 equal Parts beginning from B, and drawing the Sine, Tangent, *&c.* to all the Arches beginning at the same Point B. By this Method they draw the Lines of Sines, Tangents, *&c.* of a certain Circle on the Scale; for after drawing them on the Circle they take the Length of them, and set them off in the Lines drawn for that purpose. The same way, by supposing the Radius of any Number of equal Parts, (suppose 1000, or 10,000, *&c.*) 'tis plain the Sine, Tangent, *&c.* of every Arc must consist of some Number of these equal Parts, and by computing them in parts of the Radius, we have Tables of Sines, Tangents, *&c.* to every Arch in the Quadrant, called Natural Sines, Tangents, *&c.* and the Logarithms of these gives us Tables of Logarithmic Sines, Tangents, *&c.*

To understand the Nature of which, and the Method of using them, you must know that Logarithms are only artificial Numbers, contriv'd to avoid long Operations in natural Numbers, each of which has a Logarithm belonging to it. Their Nature is such, that Addition of them answers to Multiplication in natural Numbers, and Subtraction answers to Division; that is, when two Numbers are propos'd to be multiply'd into one another, if we take the Logarithms answering to the Numbers and add them together, the Sum will be the Logarithm answering to the natural Number, which is the Product of the two Numbers proposed.

Again, when one Number is proposed to be divided by another, if from the Logarithm of the Dividend we subtract the Logarithm of the Divisor, the Remainder shall be the Logarithm of the Quotient.

Now to apply this to practice: The first Table at the end of this Book, contains the Logarithms of all the Numbers from 1 to 10000; the Columns mark'd at the top with *(N)* contain the natural Numbers,

Numbers, and the adjacent Columns contain the Logarithms of theſe Numbers. So to find the Logarithm of any Integer Number between 1 and 10,000, we muſt look in the Columns mark'd with *N* at the top, till we find the Number propos'd; and that ſtanding on the ſame Line with it in the adjacent Column is the Logarithm required.

Example. Let it be required to find the Logarithm of 365; by looking in the Table according to the above Direction, I find it to be 2.56229. The Reverſe of this, *viz.* Given a Logarithm, to find from your Tables the natural Number anſwering thereto, is perform'd by looking into the Columns mark'd with Logarithm at top, for that which is either equal or neareſt to the one propos'd, and the Number anſwering to it in the adjacent Column is that required.

Example. Let it be required to find the natural Number anſwering to the Logarithm 2.56229, by proceeding according to the above Direction I find it to be 365.

Again, if it were required to find the Logarithm of a Number, having ſome Decimals in it. In order to do this, you may obſerve in the Table of Logarithms, that the Logarithm of 10 is 1, that of 100, 2; and of 1000, 3, *&c.* and the Logarithms of all the intermediate Numbers between 10 and 100, have 1 for the integral Part of each, and all thoſe between 100 and 1000 have 2 for their integral Part, and ſo on, which are called their Indices.

Now becauſe any Number, conſiſting of both integers and decimals, is equal to the Quotient of the whole conſider'd as an Integer divided by the Denominator of the decimal Part; and ſince by the Nature of Logarithms, Subduction in them anſwers to Diviſion in other Numbers; therefore it follows, that when a Number is given conſiſting both of in-

tegers and decimals, we can find the Logarithm anſwering thereto in the following manner: *viz.* Find the Logarithm of the whole conſider'd as an Integer; then from that take the Logarithm of the Denominator of the decimal Part, or (which is the ſame) from the Index of the Logarithm of the whole conſider'd as an Integer, ſubtract a Number leſs by Unity than the Number of Places in the Denominator of the fraction, and the Remainder will be the Logarithm required.

Example 1. Suppoſe you were to find the Logarithm of 36.5; to do this you muſt firſt look for the Logarithm of 365, which is 2.56229, then becauſe 10 is the Denominator of the decimal Part of the propos'd Number, and 1.0000 its Logarithm, therefore from 2.56229 take 1.0000, and there remains 1.56229 the Logarithm required.

Example 2. And to find the Logarithm of 6.543. Firſt find the Logarithm of 6543 conſider'd as an Integer, which by the Tables you will find to be 3.81578; then ſince 3.0000 is the Logarithm of 1000 the Denominator of the fractional Part, therefore from 3.81578 take 3.0000, and there will remain 0.81578, which is the Logarithm required.

The Reverſe of this, *viz.* the Logarithm of a Number conſiſting of integers and decimals being given to find that Number, is perform'd according to the following Method.

Rule. Look in your Table of Logarithms (without regarding the Indices) for that whoſe decimal Part is equal or nearly equal to the decimal Part of the Logarithm propoſed; then ſubtract the Index of the former from that of the latter; and laſtly divide the Number anſwering the Logarithm found in your Tables, by a Number conſiſting of an Unit, and as many Cyphers as there are Units in the difference between the two Indices; or, which is the ſame, cut off as many Figures (beginning at the loweſt

loweſt place) of the Number anſwering to the Logarithm in your Table, as there are Units in the difference of the Indices, and the Number laſt found will be that required.

Example. Suppoſe it were required to find the Number anſwering to the Logarithm 2.73608.

In order to do this, I look in the Table of Logarithms (without minding the Indices) for that whoſe decimal part is equal, or nearly equal, to .73608, the decimal part of the Logarithm propos'd, and I find it to be 3.73608; from the Index of which, *viz.* 3, I take 2, the Index of the propos'd Logarithm, and there remains 1; laſtly, I divide 5446, the Number anſwering the Logarithm found in the Tables, by 10, and the Quotient 544.6 is the Number required.

The Reaſon of this and the preceeding Rule, is plain from the very Nature of Logarithms.

From what has been ſaid on this Head we may eaſily ſolve the following Problems by the Logarithms: *viz.*

Prob. 1. Given two Numbers, as 25.6 and 134, to find the product of their Multiplication. To ſolve this by the Logarithms, I firſt look for the Logarithm of 25.6 which I find to be 1.40824, then for that of 134 which is 2.12710; then I add theſe two Logarithms together, and their Sum is 3.53534, which is the Logarithm of their product; ſo I look in my Table for the Number anſwering to 3.53534, and I find it to be 3430, which is nearly equal to the product of 25.6 into 134.

Again, if it were required to find the product of 36 into 234, I proceed as in the laſt Example, and the Operation is as follows:

	2.36922	the Logarithm of 234
	1.55630	the Logarithm of 36
Sum	3.92552	the Logarithm of their Product.

 which,

which, by the Table, I find to be 8424, which is the product of the two Numbers propos'd.

Prob. 2. Let it be requir'd to find the Quotient that arises by dividing one Number by another, suppose 828 by 23.

To solve this by the Logarithms, I first look in the Tables for the Logarithm of 828, the Dividend, which I find to be 2.91803; then for the Logarithm of 23 the Divisor, which is 1.36173, and this last taken from the former Logarithm, there remains 1.55630 the Logarithm of the Quotient, which answers to the Number 36 the Quotient required.

Again, let it be required to divide 3055 by 47; by proceeding according to the last Example, the Operation will be as follows:

3.48501 the Logarithm of 3055 the Dividend,
1.67210 the Logarithm of 47 the Divisor,

1.81291 the Logarithm of the Quotient.

which answers to the Number 65 the Quotient required.

Prob. 3. Three Numbers being given to find a fourth proportional to them, *viz.* Such as shall have the same proportion to the third as the second has to the first.

Rule. Take from the Tables the Logarithm of each of the propos'd Numbers, then add the Logarithms of the second and third together, and from the Sum take the Logarithm of the first, and the Remainder shall be the Logarithm of the fourth number requir'd.

Example. Let the three propos'd Numbers be 36, 48, 66, to which we are to find a fourth proportional; by the preceeding Rule, the Operation will stand as follows;

1.68124

1.68124	the Logarithm of 48 the 2d Term,
1.81954	the Logarithm of 66 the 3d Term,
3.50078	the Logarithm of their Product,
1.55630	the Logarithm of the 1st Term, 36.
1.94448	the Log. of the 4th Term requir'd.

which, by looking into the Table, I find answers to the natural Number 88, which is the 4th proportional to the three propos'd Numbers.

Again, let it be required to find a fourth proportional to the three Numbers 24, 144, 123; by proceeding according to the foregoing Rule, the Operation will stand as follows:

2.15836	the Logarithm of the 2d Term 144.
2.08991	the Logarithm of the 3d Term 123.
4.24827	the Logarithm of their Product,
1.38021	the Logarithm of the 1st Term 24.
2.86806	the Log. of 738, the 4th number requir'd.

Prob. 4. To find the Square of any Number by Logarithms.

Rule. Multiply the Logarithm of the given Number by 2, and the product is the Logarithm of the Square sought.

Example. Required to find the Square of 36. First I look in the Table for the Logarithm of 36, and find it to be 1.55630, which doubled gives 3.11260 the Logarithm of the Square sought, which by Inspection I find answers to the natural Number 1296 the Square of 36, *viz.* the product of 36 multiply'd into itself.

Prob. 5. To extract the square Root of any propos'd Number, *i. e.* to find a Number which multiply'd into itself, shall produce the given Number.

Rule.

Rule. Divide the Logarithm of the propos'd Number by 2, and the Quotient will be the Logarithm of the ſquare Root required.

Example. Required to find the ſquare Root of 1296. Firſt I look in the Tables for the Logarithm of 1296, and find it to be 3.11261, which divided by 2 gives 1.55630 for the Logarithm of the ſquare Root, and the natural Number anſwering thereto is 36 the Root required.

If for the Sine, Tangent, *&c.* of every Degree and Minute in the Quadrant, in the natural Tables, we take the Logarithm agreeing to each, we ſhall have a Table of Logarithmic Sines, Logarithmic Tangents, *&c.* as it is in the ſecond Table at the end of this Book.

In which you may obſerve, that each Page is divided into eight Columns, the firſt and laſt of which is Minutes, and the intermediate ones contain the Sines, Tangents, and Secants; the upper and lower Columns contain Degrees; the Column of Minutes on the left hand of each Page, anſwers to the Degrees in the top Column; and the Sines, Tangents, and Secants, belonging to theſe Degrees, and Minutes are in the Columns mark'd at the top with the Words, Sine, Tangent, Secant; the Column of Minutes on the right hand of each Page, anſwers to the Degrees in the foot of the Page, and the Sines, Tangents, and Secants, anſwering to theſe Degrees and Minutes, are in the Columns mark'd at the bottom with the Words, Sine, Tangent, Secant; the Degrees in the top Column beginning at 0, proceed to 44 where they end, and thoſe at the foot of the Page begin at 89 proceed to 45 in a decreaſing Series, the Degrees in the different Columns being the Complement of each other. From what has been ſaid, we may eaſily find the Sine, Tangent, or Secant, of any Arch, from our Tables, by looking for the given Number of Degrees at the head or foot of the

Page,

Page, according as they are leſs or greater than 45, and in the proper ſide Column for the odd Minutes, if there be any; then below or above the Word, Sine, Tangent, or Secant, and on the ſame line with the Minutes, we ſhall have that requir'd.

Example 1. Required to find the Sine of 36 *deg.* 40 *min.* To find this, I look at the head of the Page for 36 *deg.* and in the ſide Column, on the left hand, for 40 *min.* then below the Word Sine, and on the ſame line with 40, I find 9.77609, which is that requir'd.

Example 2. Requir'd the Tangent of 54 *deg.* 30 *min.* To find this, I look at the foot of the Page (becauſe the Degrees propos'd are greater than 45) for 54 *deg.* and in the right hand ſide Column for 30 *min.* then in the Column mark'd with Tangent at it's bottom, and on the ſame line with the 30 *min.* in the ſide Column, I find 10.14673, which is the Log-Tangent requir'd.

The Reverſe of this, *viz.* The Logarithm of a Sine, Tangent, or Secant, being given to find the Arch belonging to it, is perform'd by only looking in the proper Column for the neareſt Logarithm to that propos'd, and the Degrees and Minutes anſwering thereto is what was requir'd.

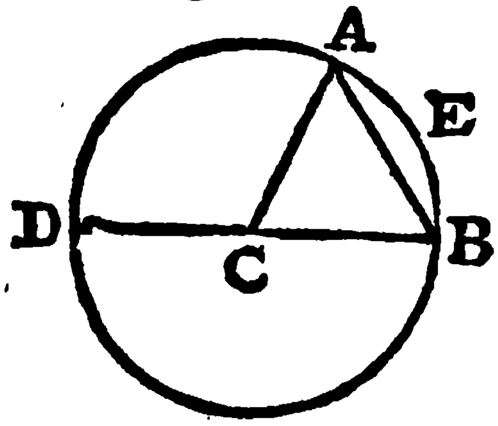
In theſe Tables the Secants might have been wanting, becauſe all the Proportions in which the Secants are concern'd may be wrought without them, by the Sines and Tangents only, as ſhall be ſhewn particularly, in the Solution of the ſeveral Caſes of plain Trigonometry.

72. The Chord, Sine, Tangent, &c. of any Arch in one Circle, is to the Chord, Sine, Tangent, &c. of the ſame Arch in another Circle, juſt as the Radius of the one is to the Radius of the other; for 'tis plain, the greater the Radius is, the greater is the Circle deſcribed by that Radius, and conſequently the greater any particular Arch of that Circle is,

and

and ſo the Sine, Tangent, &c. of that Arch is alſo the greater; therefore, in general, the Chord, Sine, Tangent, &c. of any Arch is proportionable to the Radius of the Circle.

73. In all Circles the Chord of 60 is always equal in length to the Radius. Thus in the Circle AEBD, if the Arch AEB be an Arch of 60 degrees, then drawing the Chord AB, I ſay AB ſhall be equal to the Radius CB or AC; for in the Triangle ACB, the Angle ACB is 60 degrees, being meaſured by the Arch AEB; therefore the Sum of the other two Angles is 120 degrees, (by *Cor.* 1. of 61ſt) but



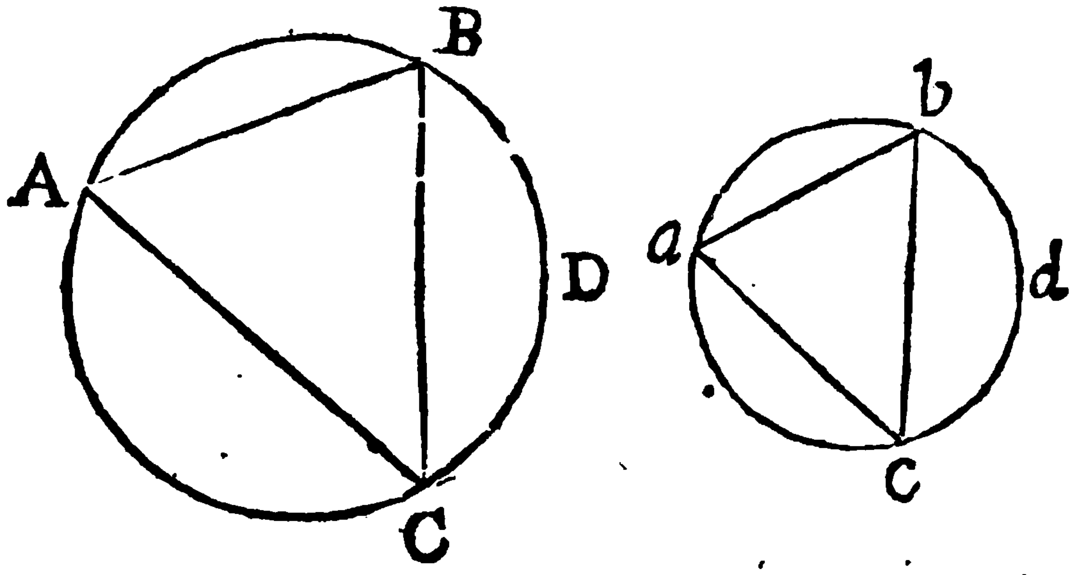
ſince AC and CB are equal the two Angles CAB, CBA will alſo be equal; conſequently each of them half their Sum 120, *viz.* 60 degrees; therefore all the three Angles are equal to one another, conſequently all the Legs, therefore AB is equal to CB.

Cor. Hence the Radius from which the Lines on any Scale were form'd, is the Chord of 60 on the Line of Chords.

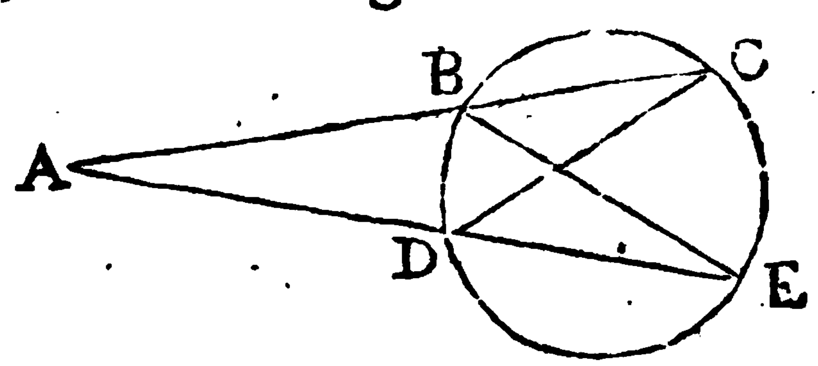
74. If in two Triangles ABC, *abc* all the Angles of the one be equal to all the Angles in the other, each to each reſpectively, that is, the Angle BAC equal to the Angle *bac*, the Angle ACB equal to the Angle *acb*, and the Angle ABC equal to the Angle *abc*; then the Legs oppoſite to the equal Angles are proportionable, *viz.* AB : *ab* :: AC *ac* and AB : *ab* :: BC : *bc* and AC : *ac* :: BC : *bc*; for being inſcribed in two Circles, 'tis plain, ſince the Angle BAC is equal the Angle *bac*, the Arch BDC is equal the Arch *bdc*, and conſequently the Chord BC is to the Chord *bc*, as the Radius of the Circle ABC to the Radius of the Circle *abc* (by the 72d); the ſame way the Chord

AB

AB is to the Chord *ab* in the same proportion. So AB : *ab* : : BC : *bc* ; the same way we may prove all the rest to be proportional.



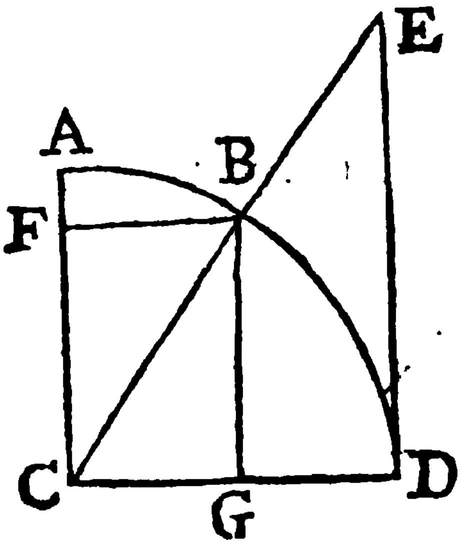
75. If from a point A without a Circle DBCE, there be drawn two Lines ADE, ABC, each of them cutting the Circle in two points ; then, I say, the product of the one whole Line into its external part, *viz.* AC into AB, is equal to the Rectangle of the other line into its external part, *viz.* AE into AD: for drawing the lines DC, BE, 'tis plain in the two Triangles ABE, ADC, the Angle AEB in the one is equal to the Angle ACD in the other (by *Cor.* 2. of 63d), and the Angle at A is common ; therefore, the other Angle ADC is equal the Angle ABE (by *Cor.* 1. of 61.) therefore the Triangle



ABE is equiangular to the Triangle ADC ; Consequently AC : AE : : AD : AB by the last, and therefore AC into AB is equal to AE into AD.

76. Let ABD be a Quadrant of a Circle described by the Radius CD ; BD any Arch of it, and BA its Complement, BG or CF the Sine, CG or BF the Co-Sine, DE the Tangent, and CE the Secant of that Arch BD. Then since the Triangles CDE, CGB are similar, or equiangular, it

will be by (*Art.* 74.) DE : EC : : GB : BC *i.e.* the Tangent of any Arch, is to the Secant of the same, as the Sine of it is to the Radius. Also since DE



: EC : : GB : BC, therefore by inverting that proportion we have EC : DE : : BC : GB *i.e.* the Secant is to the Tangent, as the Radius is to the Sine of any Arch.

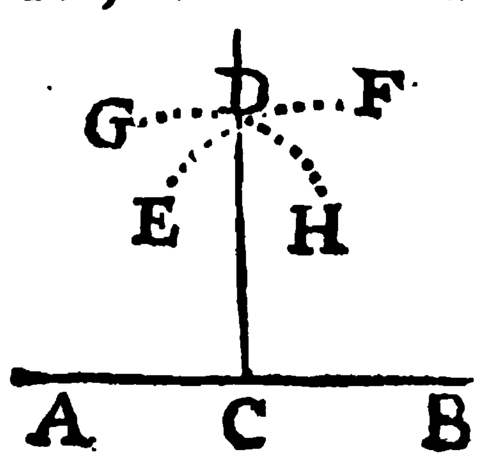
Again, since the Triangles CDE, CGB are similar, therefore (by *Art.* 74.) it will be CD : CE : : CG : CB *i.e.* as the Radius is to the Secant of any Arch, so is the Co-Sine of that Arch to the Radius. And by inverting the proportion we have this, *viz.* As the Secant of any Arch is to the Radius, so is the Radius to the Co-Sine of that Arch.

Having thus gone thro' the Theorems of *Geometry*, that are necessary for the Knowledge of *Navigation*; we shall next proceed to some Problems that are useful for the Practice of that Art.

Geometrical Problems.

Prob. 1. FROM a point C in a given Line AB to raise a Perpendicular to that Line.

Rule. From the point C take the equal distances CB, CA on each side of it. Then stretch the

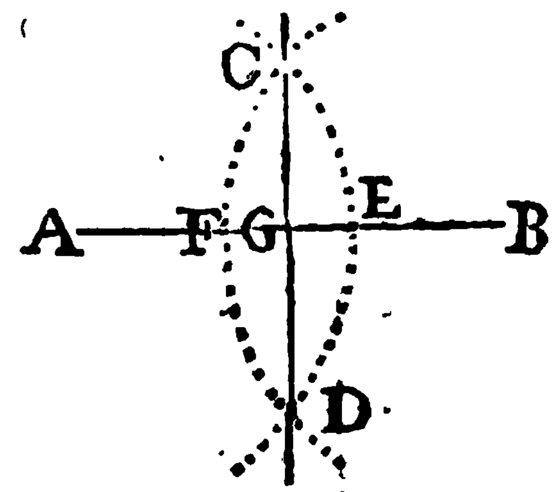


Compasses to any distance greater than CB or CA, and with one Foot of them in B, sweep the Arch EF with the other; again, with the same opening, and one Foot in A, sweep the Arch GH with the other, and these

theſe two Arches will interſect one another in the point D; then join the given points C and D with the line C D, and that ſhall be the Perpendicular required.

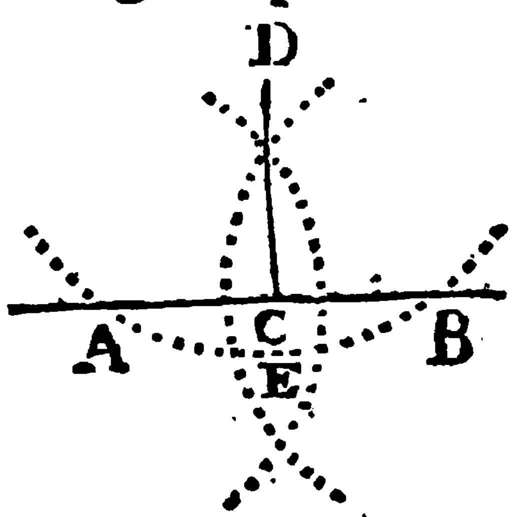
2. To divide a given right Line A B into two equal parts; that is, to biſect it.

Rule. Take any diſtance with your Compaſſes that you are ſure is greater than half the given line; then ſetting on foot of them in B, with the other ſweep the Arch D F C; and with the ſame diſtance and one foot in A, with the other ſweep the Arch C E D; theſe two Arches will interſect one another in the points C, D, which join'd by the right Line D C will biſect A B in G.



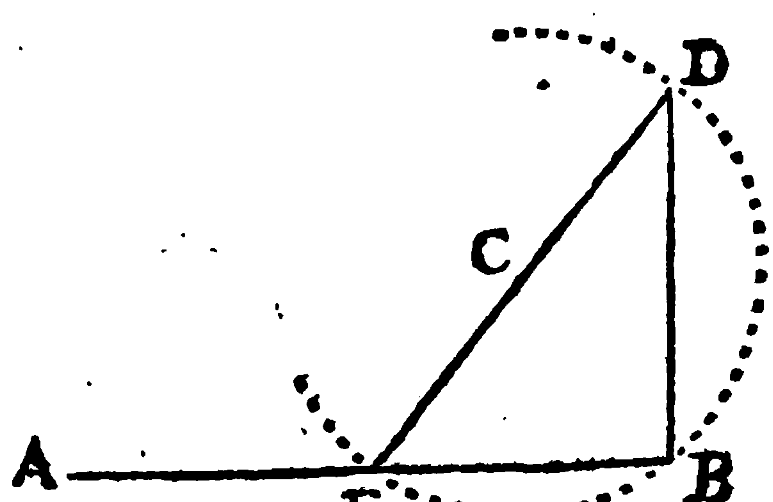
3. From a given point D to let fall a Perpendicular on a given Line A B.

Rule. Set on foot of the Compaſſes in the point D, and extend the other to any diſtance greater than the leaſt diſtance between the given point and and the line, and with that extent ſweep the Arch A E B, cutting the line in the two points A and B, then (by the laſt Problem) biſect the line A B in the point C, laſtly join C and D, and that line C D is the Perpendicular required.



4. Upon the end B of a given right Line B A, to raiſe a Perpendicular.

Rule. Take any Extent in your Compaſſes, and with one foot in B fix the other in any point C,

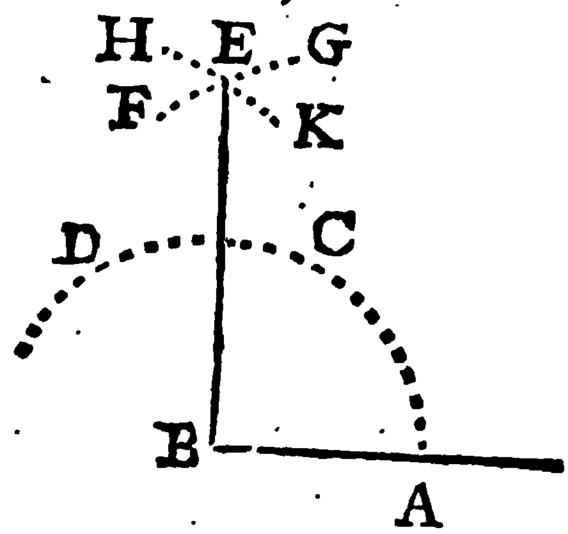


 with-

without the given Line, then with one point of the Compasses in C, describe with the other, the Circle EBD, and thro' E and C draw the Diameter ECD meeting the Circle in D; join D and B, and the right line DB is that required; for EBD is a right Angle (by *Cor.* 4. of 63d).

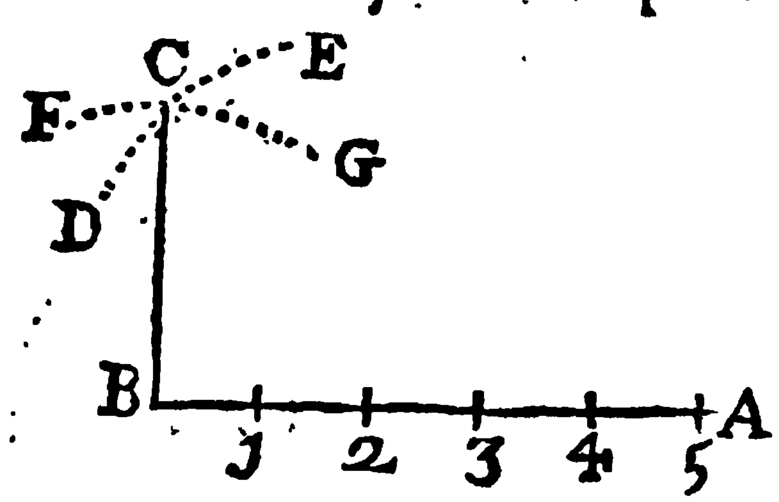
Another Way.

Upon the point B as a Center, and with any distance BA, describe the Circle ACD; set off the Radius from A to C and from C to D, then with the same Extent of the Compasses, and one foot in C, describe with the other foot the Arch FG, and with the same opening on the Center D describe the Arch KH which will cut the former in E, then join EB and that shall be the Perpendicular requir'd.



Another Way.

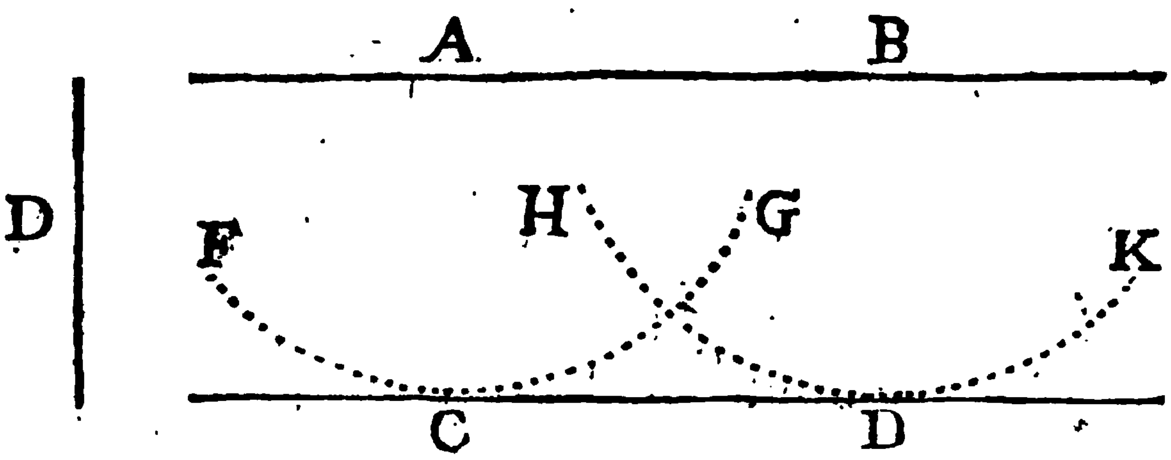
From the point B set off with your Compasses five small equal parts; then with the distance of all the five taken in your Compasses, setting one foot at the fourth Division, *viz.* in the point 4, with the other describe the Arch DE; Again, Taking the length of three of them in your Compasses, *viz.* B 3, and setting one foot of them in B, with the other describe the Arch FG intersecting the former in the point C, join CB and that is the line required.



5. To

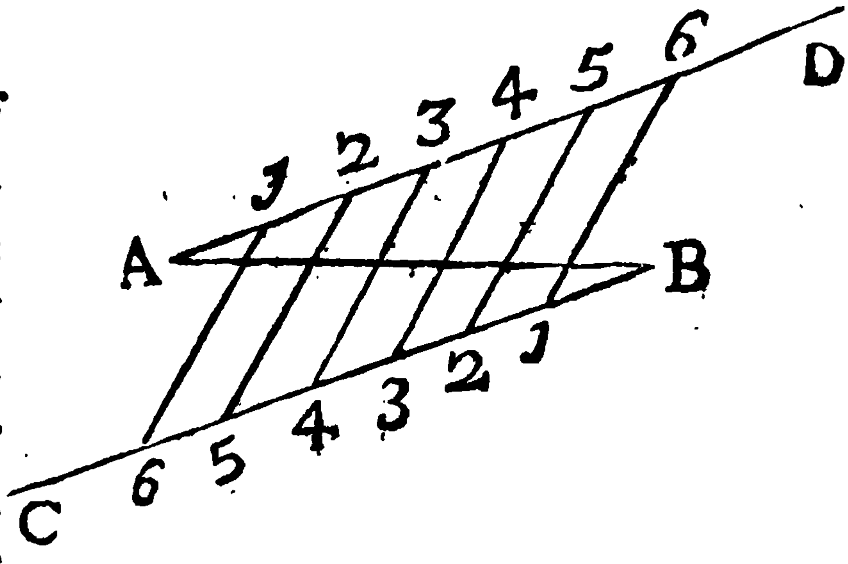
5. To draw one Line parallel to another given Line AB, that shall be distant from one another by any given distance D.

Rule. Extend your Compasses to the given distance D; then setting one foot of them in any point of the given Line (suppose A) with the other sweep the Arch FCG; again, at the same Extent, and one foot in any other point of the given Line B sweep the Arch HDK, and draw the Line CD touching them, and that will be parallel to the given Line AB, and distant from it by the Line D as was requir'd.

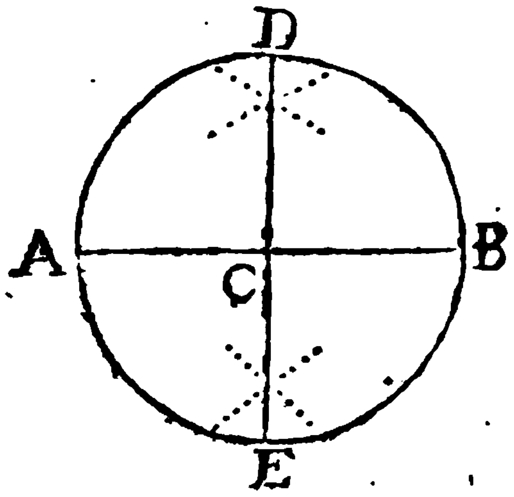


6. To divide a given Line AB into any Number of equal parts, suppose 7.

Rule. From the point A draw any Line AD, making an Angle with the line AB, then thro' the point B draw a line BC parallel to AD; and from A, with any small opening of the Compasses, set off a Number of equal parts (on the line AD) less by one than the propos'd Number (here 6.), then from B set off the same Number of the same parts on the line BC; lastly, join 6 and 1, 2 and 5, 3 and 4, 4 and 3, 5 and 2, 6 and 1, and these lines will cut the given line as requir'd.



7. To

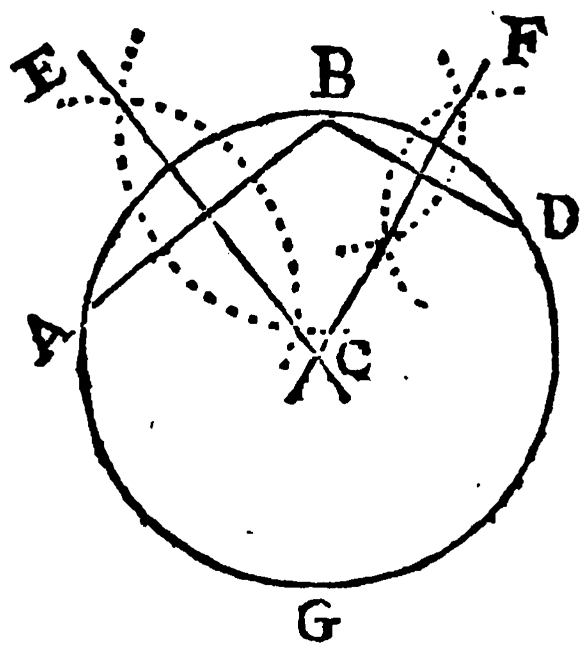


7. To quarter a given Circle, or to divide it into four equal parts.

Rule. Thro' the Center C of the given Circle draw a Diameter A B, then upon the point C raiſe a Perpendicular D C E to the line A B; and theſe two Diameters A B and D E ſhall quarter the Circle.

8. Thro' three given points A, B, and D to draw a Circle. (*Note*, the three points muſt not lie in the ſame ſtreight Line.)

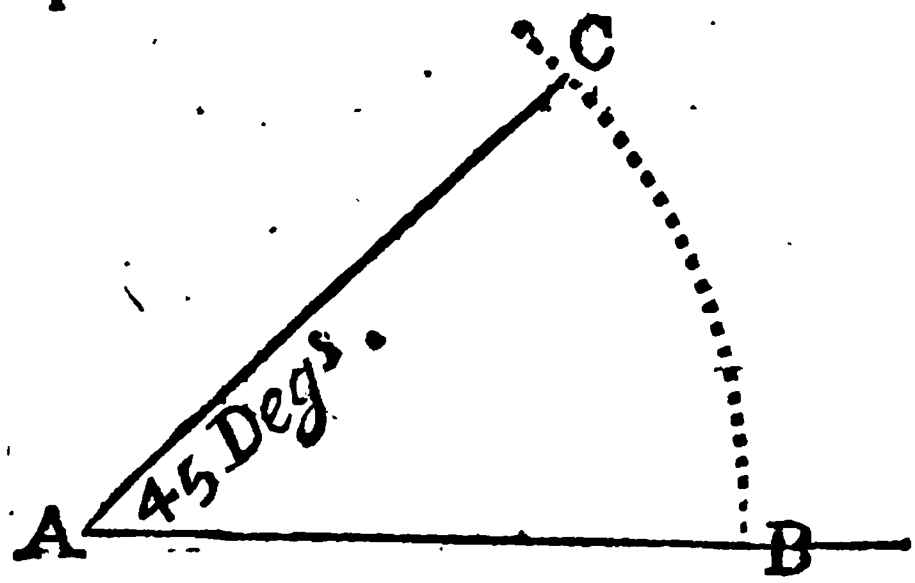
Rule. Join A and B alſo B and D with the ſtreight lines A B, B D, then by *Prop.* 2. biſect A B with the line E C, alſo B D with the line F C, which two lines will cut one another in ſome point C, that is the Center of the Circle requir'd; then fixing one point of your Compaſſes in D, and ſtretching the other to A, deſcribe the Circle A B D G, which will paſs thro' the three points given. The Reaſon of this is plain from *Cor.* 1. of *Art.* 65.



9. From the point A of the given line A B, to draw another line (ſuppoſe A C) that ſhall make with A B an Angle of any Number of Degrees, ſuppoſe 45.

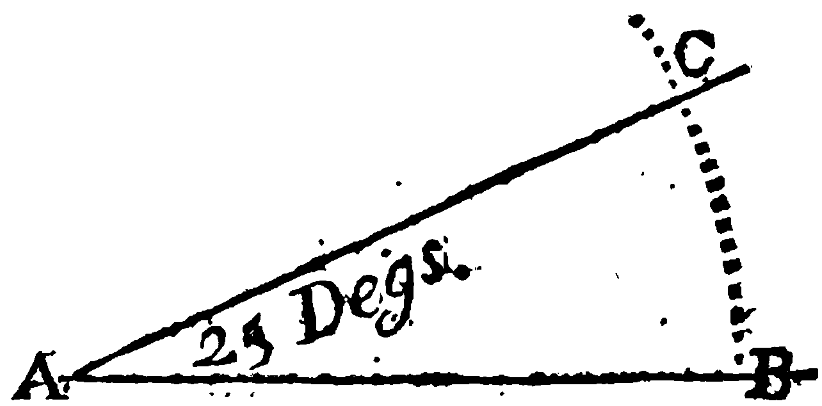
Rule. Let the given line A B be produced, then take off your Scale the length of the Chord of 60 Degrees, which is equal to the Radius of the Circle the Scale was made for (by *Art.* 73.) And ſetting one foot in A, with the other ſweep the Arch B C; then with your Compaſſes take from your Scale the Chord

Chord of 45 Degrees, and set off that distance from B to C. Lastly join A and C, and the line A C is that requir'd. For the Angle C A B, which is measur'd by the Arch B C, is an Angle of 45 Degrees as was requir'd.



10. An Angle B A C being given, to find how many Degrees it contains.

Rule. With your Compasses take the length of the Chord of 60 from your Scale. Then setting one foot of them in A, with the other sweep the Arch B C, which is the Arch comprehended between the two Legs A B, A C produc'd if needful. Lastly, take with your Compasses the Distance B C, and applying it to your line of Chord on the Scale, you'll find how many Degrees the Arch B C contains; and consequently the Degrees of the Angle B A C which was requir'd.

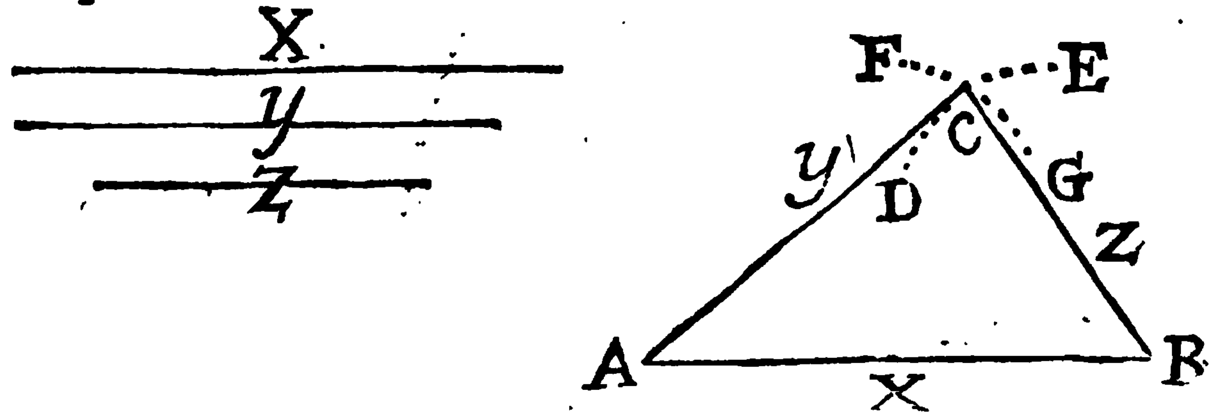


11. Three lines x, y, and z being given, to form a Triangle of them, but any two of these lines taken together, must always be greater than the third.

Rule. Make any one of them, as x, the Base; then with your Compasses take another of them, as

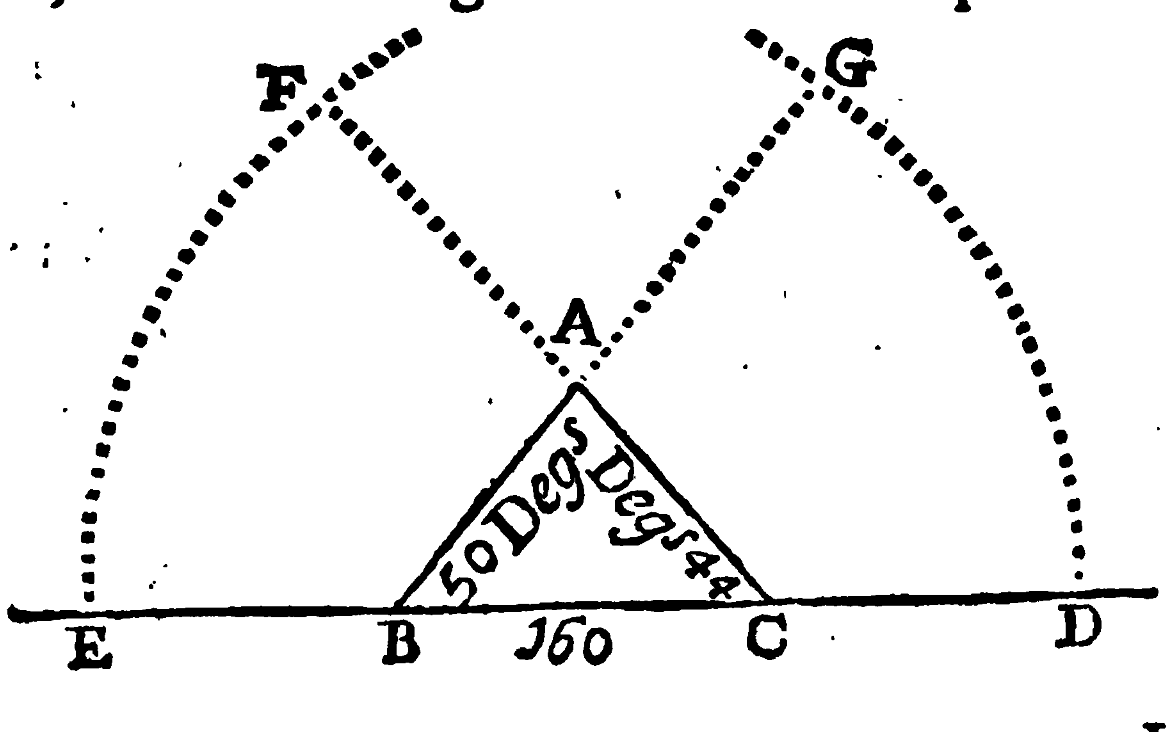
z,

z, and setting one foot in one end of the line x, as B, with the other sweep the Arch D E; and taking with your Compasses the length of the other y, set one foot of them in A, the other end of the line x, and with the other sweep the Arch F G, which will cut the other in C; lastly, join C A and C B, and the Triangle C A B is that requir'd.



12. To make a Triangle having one of its Legs of any Number of equal parts (suppose 160), and one of the Angles at that Leg 50 Degrees and the other 44 Degrees.

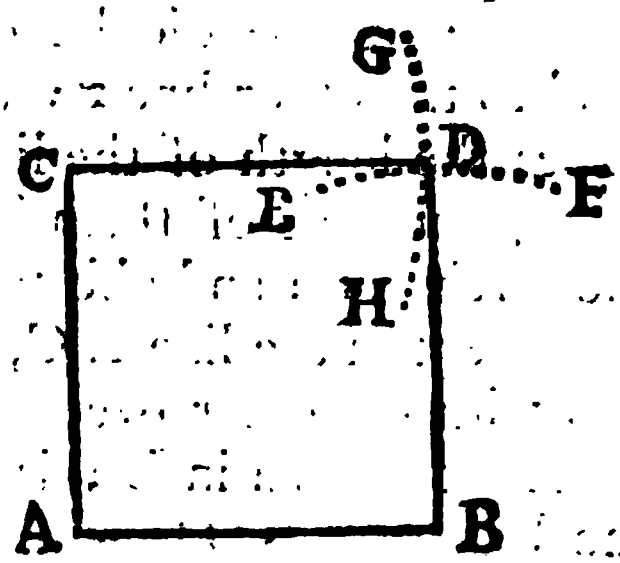
Rule. Draw an indefinite Line E D, then take off the Line of equal Parts with your Compasses; 160 of them, and set them on the indefinite Line, as B C then (by *Prob.* 9.) draw B A making the Angle ABC of 50 Degrees, and by the same, draw from C the Line A C, making the Angle A C B of 44 Degrees; which two Lines will meet one another in A, and the Triangle A B C is that required.



13. Up-

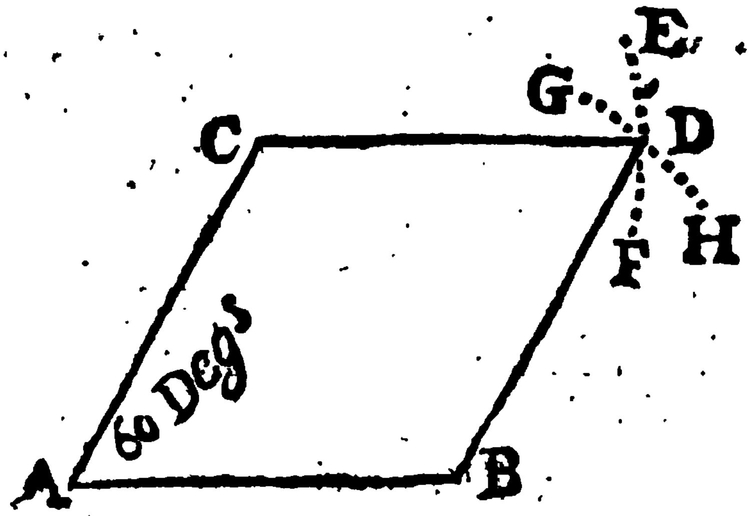
13. Upon a given Line AB to make a Square.

Rule. Upon the Extremity A of the given line AB raise a Perpendicular AC (by *Prob.* 4.); then take AC equal to AB, and with that extent, setting one foot of the Compasses in C, sweep with the other foot the Arch GH, then with the same extent and one foot in B, with the other sweep the Arch EF, which will meet the former in some point D; lastly, join C and D, D and B, and the Figure ABDC will be the Square requir'd.



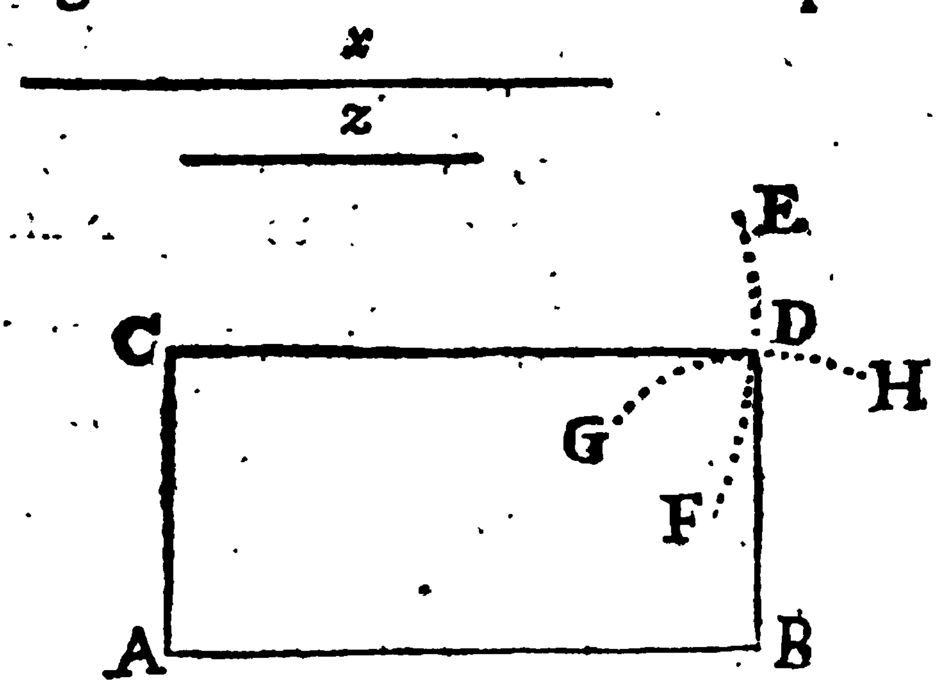
14. On a given line AB to draw a Rhomb that shall have one of its Angles equal to any Number of Degrees, suppose 60 Degrees.

Rule. From the point A of the given line AB draw the line AC, making the Angle CAB of 60 *Deg.* (by *Prob.* 9.); then take AC equal to AB, and with that extent fixing one foot of the Compasses in B, with the other describe the Arch GH, and at the same extent fixing one foot of the Compasses in C, with the other describe the Arch EF cutting the former in D; lastly, join CD and DB and the Figure ACDB is that requir'd.



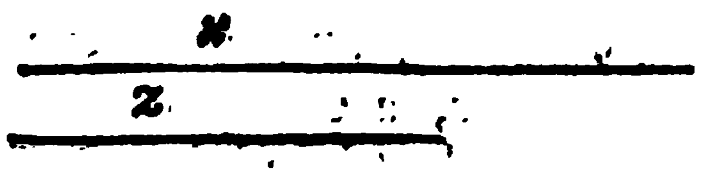
15. Given two lines *x* and *z*, of these two to make a Rectangle.

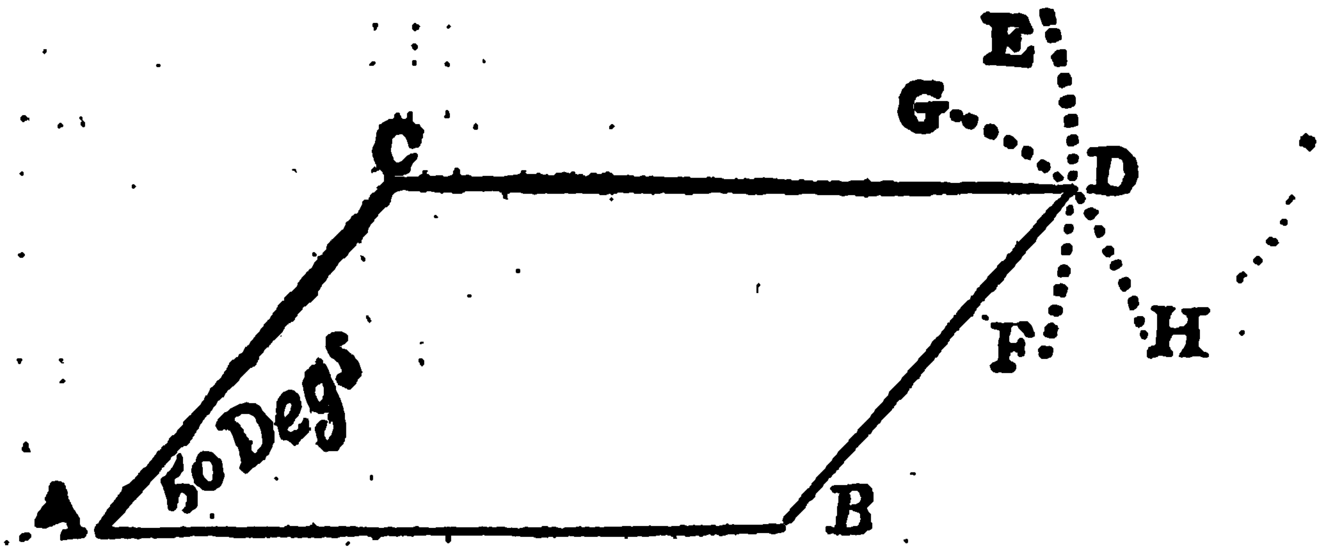
Rule. Draw a line, as AB, equal in length to one of the given lines *x*, and on the extremity A of that line raise a Perpendicular AC, on which take AC equal to the other line *z*; then take with your Compasses the length of the line AB, and at that extent fixing one foot of them in C, with the other sweep the Arch EF; and also taking with your Compasses the extent of the line AC, fix one foot of them in B and with the other sweep the Arch GH, which will meet the former in D; lastly join CD and BD, and the Figure ABDC will be that requir'd.



16. Two lines *x* and *z* being given, of these to form a Rhomboides that shall have one of its Angles any Number of Degrees, suppose 50.

Rule. Draw a line AB equal in length to one of the lines as *x*; then draw the line AC, making with the former the Angle BAC equal to the propos'd, suppose 50 Degrees, and on that line take AC equal to the given line *z*, then with your Compasses take the length of AB, and fixing one foot in C sweep the Arch EF; also taking the length of AC and setting one foot in B, with the other sweep the Arch GH, which will cut the former in D; then join CD and DB, so the Figure ACDB will be that required.





And thus we have gone thro' all *Geometry* that is necessary for our present Business, both as to Theory and Practice. The next thing we go on, is the Principles of *Plain Trigonometry*.

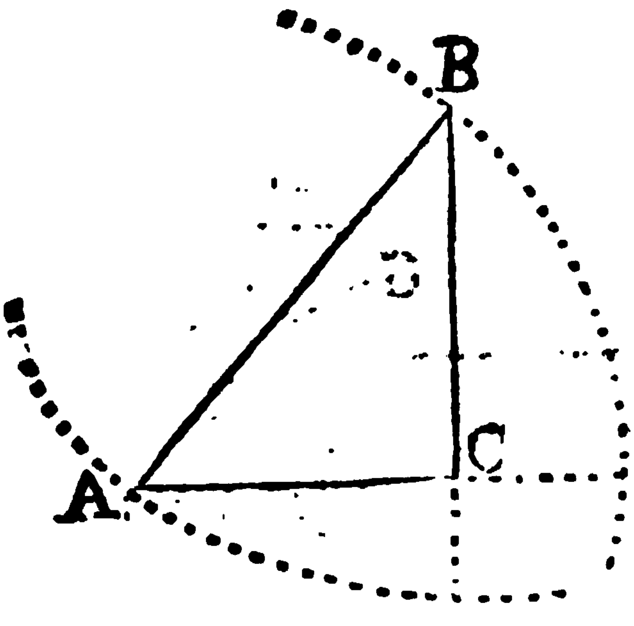
SECT. II.

Of Plain TRIGONOMETRY, *Right and Oblique Angled.*

1. PLAIN *TRIGONOMETRY* is that Science by which we measure the Sides and Angles of plain Triangles.

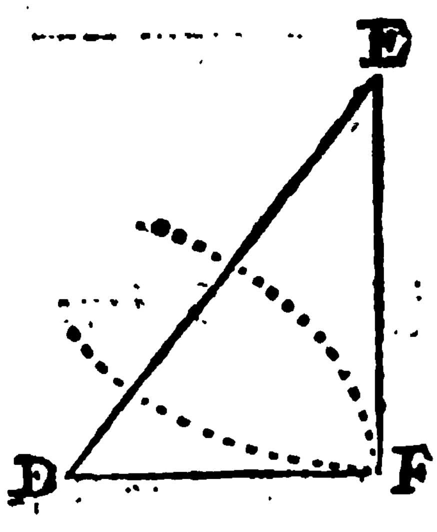
2. Since Triangles are either right or oblique angled; therefore Trigonometry is commonly divided into two kinds, *viz. Rectangular* and *Oblique-angular*: and first we shall treat of Rectangular.

3. In any right angled Triangle as ABC, if the Hypothenuse be made the Radius, and with that a Circle be described on the one end A as a Center; then 'tis plain that BC will be the Sine of the Angle BAC (by *Art.* 21. of *Sect.* I.); and if with the same



diſtance, and on B as a Center, a Circle be deſcribed, 'tis plain that A C will be the Sine of the Angle A B C; therefore, in general, if the Hypothenuſe of a right angled Triangle be made the Radius, the two Legs will be the Sines of their oppoſite Angles.

4. If in a right angled Triangle D E F, one of the Legs, as D F, be made the Radius, and on the Extremity D (at one of the oblique Angles, *viz.* that which is form'd by the Hypothenuſe and the Leg made Radius) as a Center, a Circle be deſcribed; 'tis plain, that the other Leg E F will be the Tangent of the Angle at D, and the Hypothenuſe D E will be the Secant of the ſame Angle (by *Art.* 24, 25, and 67 of *Sect.* 1.). The ſame way, making the Leg E F the Radius, and on the Center E deſcribing a Circle, the other Leg G F will become the Tangent of the Angle at E, and the Hypothenuſe D E the Secant of the ſame.



5. It has been already ſhewn, at *Art.* 72. of *Sect.* 1. that the Chord, Sine, Tangent, &c. of any Arch, or Angle, in one Circle, is proportionable to the Chord, Sine, Tangent, &c. of the ſame Arch in any other Circle; from which, and the two foregoing Articles the Solutions of the ſeveral Caſes of rectangular Trigonometry naturally follows.

6. Since Trigonometry conſiſts in determining Angles and Sides from others given, there ariſes various Caſes, which are ſeven in Rectangular and ſix in Oblique-angular Trigonometry.

We

We shall now proceed to the Solution of the seven Cases of Rectangular Trigonometry.

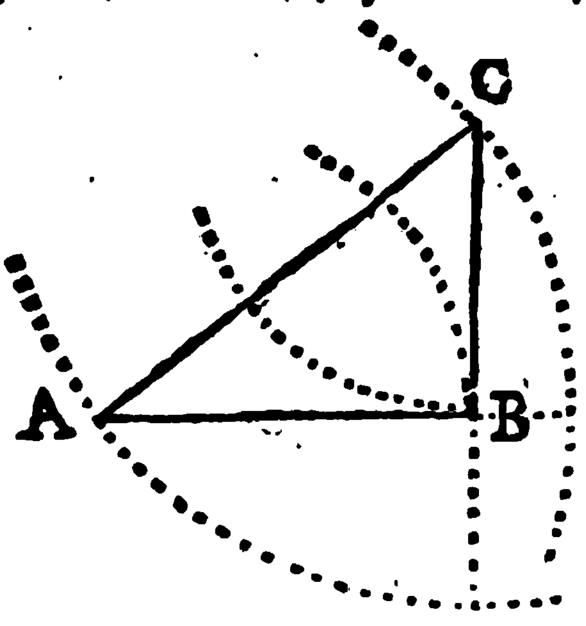
CASE I.

The Angles and one of the Legs given, to find the other Leg.

Example. In the Triangle ABC rightangled at B, suppose the Leg AB, 86 equal parts, (as Feet, Yards, Miles, *&c.*) and the Angle A 33°, 40′ requir'd the other Leg BC in the same parts with AB.

Geometrically.

Draw AB equal to 86, from any Line of equal parts, then (by *Prob.* 4. of *Sect.* 1.) upon the point B, erect the Perpendicular BC; lastly, from the point A draw the line AC, making with AB an Angle equal to 33°, 40′, and that line produc'd will meet BC in C, and so constitute the Triangle. The length of BC may be found by taking it in your Compasses, and applying it to the same line of equal parts that AB was taken from.



By Calculation.

First by making the Hypothenuse AC Radius, the other two Legs will be the Sines of their opposite Angles (by *Art.* 3. of this) *viz.* AB the Sine of C, and CB the Sine of A; now since (by *Art.* 72. of *Sect.* 1.) the Sine, Tangent, *&c.* of any Arch in one

one Circle is proportionable to the Sine, Tangent, &c. of the ſame Arch in any other Circle, 'tis plain the Sines of the Angles A and C in the Circle deſcribed by the Radius A C, muſt be proportional to the Sine of the ſame Arches or Angles, in the Circle, that the ſecond Table at the end of this Book was calculated for; ſo the proportion for finding BC will be

S, C : AB : : S, A : BC.

i. e. As the Sine of the Angle C in the Tables, is to the length of AB (or Sine of C in the Circle whoſe Radius is AC) ſo is the Sine of the Angle A in the Tables, to the length of BC (or Sine of the ſame Angle in the Circle whoſe Radius is AC).

Now the Angle A being 33°, 40′, the Angle C muſt be 56°, 20′ (by *Art.* 61. *Cor.* 2. *Sect.* 1.); therefore looking in the ſecond Table at the end of this Book for the Sines of the two Angles, and in the firſt for the Logarithm of 86 the given Leg, we ſhall find by proceeding according to the foregoing proportion, that the required Leg BC, is 57.28; and the Operation will ſtand as follows.

1.93450	AB	86
9.74380	S, A	33°, 40′
11.67830		
9.92027	S, C	56°, 20′
1.75803	BC	57.28

2*dly*, Making AB the Radius, 'tis plain BC, the Leg required, will be the Tangent of the given Angle A (by the 4th of this), and ſo the proportion for finding BC, when AB is made the Radius, will be,

R : T, A : : AB : BC.

i. e. as the Radius in the Tables, is to the Tangent of the Angle A in the ſame, ſo is the length of BA, or

or Radius in the Scheme, to the length of BC or Tangent of A in the Scheme; therefore looking in the Tables for the parts given in the foregoing proportion, and proceeding with them according to that Rule, we ſhall find BC to be 57.28 as before, and the Operation will be as follows:

9.82352	T, A	33°, 40′
1.93450	AB	86
11.75802		
10.00000	Rad.	90°
1.75802	BC	57.28

Laſtly, by making BC, the Leg requir'd, the Radius, 'tis plain that AB will be the Tangent of C, and the proportion for finding BC will be as follows:

T, C : R : : AB : BC

i. e. as the Tangent of C	56°, 20′	10.17648
is to Radius - - - - -	90° -	10.00000
ſo is the Length of AB - -	86 -	1.93450
		11.93450
		10.17648
to the Length of BC -	57.28 -	1.75802

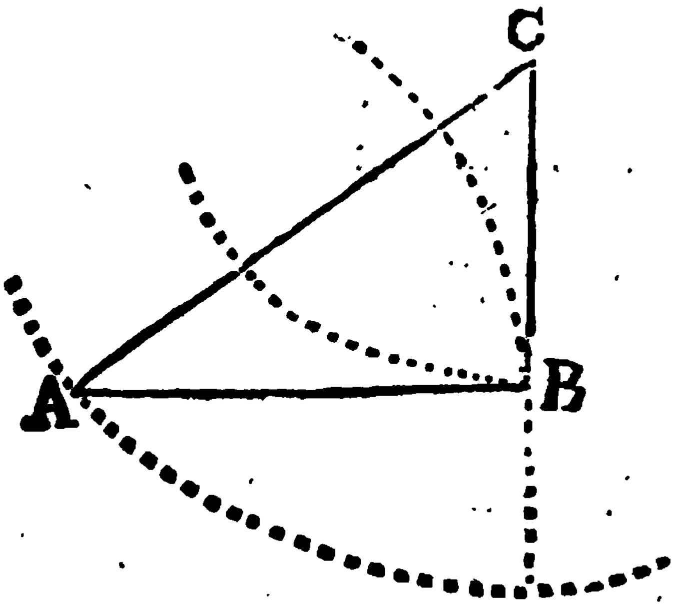
CASE 2.

The Angles and one of the Legs given, to find the Hypothenuſe.

Example. In the Triangle ABC, ſuppoſe AB 124, and the Angle A 34°, 20′; conſequently the Angle C 55°, 40′ requir'd the Hypothenuſe AC, in the ſame parts with AB.

Geometrically.

Geometrically.



This Caſe is conſtructed after the ſame manner with the former, and the Hypothenuſe A C is found by taking it's length in your Compaſſes, and applying that to the ſame line of equal parts you took A B from.

By Calculation.

1*ſt*, By making A C the Radius we ſhall have the following proportion for finding A C, *viz.*

S, C : R : : A B : A C

i. e. as the Sine of C	55°, 40′	9.91686
is to Radius - - - - -	90 - - -	10.00000
ſo is A B - - - - - -	124 - - -	2.09342
to A C - - - - - -	150.2 - - -	2.17656

2*dly*, Making A B the Radius we have this proportion, *viz.*

R : Sec. A : : A B : A C

i. e. as Radius - -	90° - -	10.00000
is to the Secant of A -	34°, 20′ -	10.08314
ſo is A B - - - - - -	124 - -	2.09342
to A C - - - - - -	150.2 - -	2.17656

This may be done without the help of the Secants; for ſince (by *Art.* 76. *Sect.* 1.) R : Sec. : : Co-S. : R; therefore the former proportion will become

Co-S. A : R : : A B : A C

i. e. As

i. e. As the Co-Sine of A	34°, 20′		9.91686
is to the Radius - - - - -	90°	-	10.00000
so is AB - - - - - - -	124	-	2.09342
to AC - - - - - - - -	150.2	-	2.17656

3*dly*, Making BC the Radius, we have the following proportion, *viz.*

T, C : Sec. C : : AB : AC

i. e. as the Tangent of C	55°, 40′	10,16558
is to Sec. C - - - - - -	55°, 40′	10.24872
so is A B - - - - - - - -	124 -	2.09342
to A C - - - - - - - -	150.2 -	2.17656

This likewise may be done without the help of Secants, for since (by *Art.* 76. *Sect.* 1.) T, : Sec. : : S, : R ; therefore the former Analogy will be reduc'd to this, *viz.*

S, C : R : : AB : AC

where no Secants do appear, and it coincides with that in the first supposition of this Case, so we shall not repeat the Operation.

CASE 3.

The Angles and Hypothenuse given, to find either of the Legs.

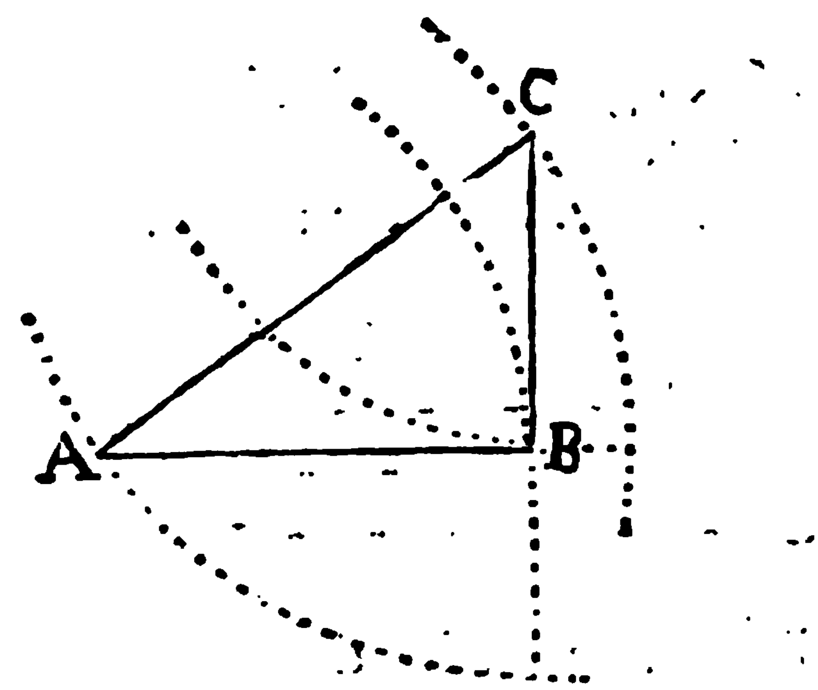
Example. In the Triangle ABC, suppose the Hypothenuse AC 146 equal parts, and the Angle A 36°, 25′, consequently the Angle C 53°, 35′, requir'd the Leg AB.

Geometrically.

Draw the Line AB at pleasure, and make the Angle BAC equal to 36°, 25′ (by *Prob.* 9. *Sect.* 1.) then take AC equal to 146 from any Line of equal

 parts;

parts; laſtly from the point C let fall the perpendicular CB on the line AB. So the Triangle is conſtructed, and AB may be meaſured from the line of equal parts.



By Calculation.

1*ſt*, Making AC the Radius we ſhall have the following proportion, *viz.*

R : S, C : : AC : AB

i. e. as Radius	- - -	90° - -	10.00000
is to the Sine of C	- -	53°, 35′ -	9.90565
ſo is AC	- - - - - -	146 - -	2.16435
to AB	- - - - - -	117.5 - -	2.07000

2*dly*, Making AB the Radius, we have the following Analogy, *viz.*

Sec. A : R : : AC : AB

i. e. as the Secant of A	-	36°, 25′ -	10.09435
is to Radius	- - - - -	90 - -	10.00000
ſo is AC	- - - - - -	146 - -	2.16435
to AB	- - - - - -	117.5 - -	2.07000

This may be done without the help of Secants, for ſince (by *Art.* 76. *Sect.* 1.) Sec. : R : : R : Co-S; therefore the former proportion may be reduc'd to this, *viz.*

R:

R : Co-S, A : : A C : A B

which is the same with the proportion in the first supposition.

3*dly*, By supposing B C the Radius, we have the following proportion, *viz.*

Sec. C : T. C : : A C : A B

i. e. as the Secant of C	53°, 35′	10.22647
is to the Tangent of C	53°, 35′	10.13212
so is A C - - - - - -	146 -	2.16435
to A B - - - - - - -	117.5 -	2.07000

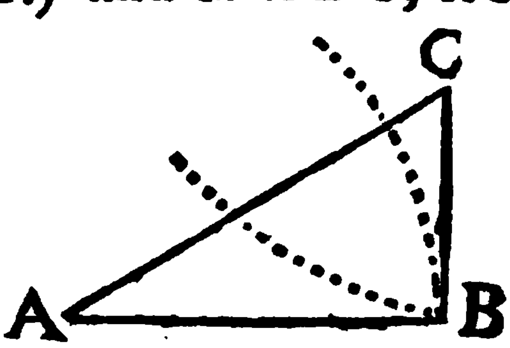
C A S E 4.

The two Legs being given, to find the Angles.

Example. In the Triangle A B C, suppose A B 94 and B C 56, requir'd the Angles A and C.

Geometrically.

Draw A B equal to 94, from any line of equal parts, then from the point B raise B C perpendicular to A B (by *Prob.* 4. *Sect.* 1.) and take B C, from the former line of equal parts equal to 56; lastly, join the points A and C with the streight line A C, so the Triangle is constructed, and the Angles may be measur'd by *rob.* 10. *Sect.* 1.



By Calculation.

1*st*, Supposing A B the Radius we have this Analogy, *viz.*

A B : B C : : R : T. A

i. e. as A B - - -	94 - - -	1.97313
is to B C - - - - -	56 - - - -	1.74819
so is the Radius - -	90° - - - -	10.00000
to the Tangent of A	30°, 47′ - -	9.77506

 2*dly*,

2*dly*, Making BC the Radius we have this proportion, *viz.*

BC : BA : : R : T.C

i. e. as BC	- - - - 56	- - - -	1.74819
is to AB	- - - - 94	- - - -	1.97313
so is the Radius	- - 90°	- - -	10.00000
to the Tangent of C	59°, 13′	- -	10.22494

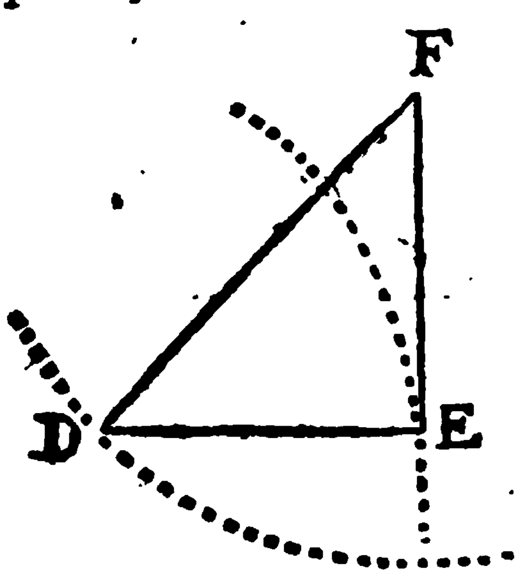
CASE 5.

The Hypothenuse, and one of the Legs given, to find the Angles.

Example. In the Triangle DEF, suppose the Leg DE 83, and the Hypothenuse DF 126, requir'd the Angles D and F.

Geometrically.

Draw the line DE 83, from any line of equal parts, and from the point E raise the perpendicular EF, then take the length of DF 126, from the same line of equal parts, and setting one foot of your Compasses in D with the other cross the perpendicular EF in F; lastly, join D and F, so the Triangle is constructed, and the Angles may be measured by *Prob.* 10, *Sect.* 1.



By Calculation.

1*st*, Making DF the Radius, we have this proportion, *viz.*

DF : DE : : R : S, F

i. e.

i. e. as DF - - - -	126 - -	2.10037
is to DE - - - - -	83 - -	1.91908
so is the Radius - -	- 90° - -	10.00000
to the Sine of F -	41°, 12′ - -	9.81871

2*dly*, By supposing DE the Radius, we have the following Analogy, *viz.*

DE : DF : : R : Sec, D

i. e. as DE - - - -	83 - - -	1.91908
is to DF - - - - -	126 - - -	- 2.10037
so is the Radius - -	90° - -	10.00000
to the Secant of D -	48°, 48′ -	10.18129

This may be done without the help of Secants, for since by *Art.* 76. *Sect.* 1. R : Sec, : : Co-S : R; therefore the preceeding Analogy will become this, *viz.*

DF : DE : : R : Co-S, D.

in which no Secants do appear; and it plainly coincides with the proportion deduc'd from the first Supposition.

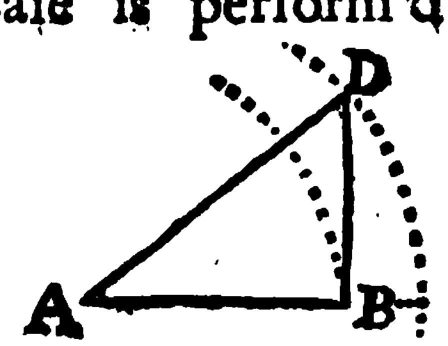
CASE 6.

The two Legs given, to find the Hypothenuse.

Example. In the Triangle ABD, suppose the Leg AB, 64, and BD, 56, requir'd the Hypothenuse.

Geometrically.

The Construction of this Case is perform'd the same way as in the fourth Case, and the length of the Hypothenuse AB is found by taking it in your Compasses, and applying it to the same line of equal parts, that the two Legs were taken from.



By

By Calculation.

This Case being a Compound of the *4th* and *2d* Cases, we must first find the Angles by the *4th* thus:

AB : DB : : R : T, A

i. e. as the Leg A B	64		1.80618
is to the Leg D B	56		1.74819
so is the Radius	90		10.00000
to the Tangent of A	41°, 11′		9.94201

Then by the *2d* Case we find the Hypothenuse requir'd thus:

S, A : R : : BD : AD

i. e. as the Sine of A	41°, 11′	9.81854
is to the Radius	90°	10.00000
so is the Leg BD	56	1.74819
to the Hypothenuse AD	85.05	1.92965

This Case may also be solv'd after the following manner, *viz.*

From twice the Log. of the greater side AB 3.61236
subtract the Log. of the lesser side B D - 1.74819

and there remains - - - - - - - - 1.86417
the Logarithm of 73.15 to which adding the lesser side BD, we shall have 189.15 whose Log. is 2.11093
to which add the Log. of the lesser side BD 1.74819

and the Sum will be - - - - - - - - 3.85912
the half of which is - - - - - - - - 1.92956
the Logarithm of the Hypothenuse required.

Or it may be done by adding the square of the two sides together, and taking the Logarithm of that Sum, the half of which is the Logarithm of the Hypothenuse requir'd thus in the present Case:

The

the square of A B (64) is - - - - - -	4096
the square of B D (56) is - - - - - -	3136
the sum of these squares, is - - - - -	7232
the Logarithm of which, is - - - -	3.85926
the half of which, is - - - - - - - -	1.92963

the Logarithm of 85.05 the Length of the Hypothenuse requir'd.

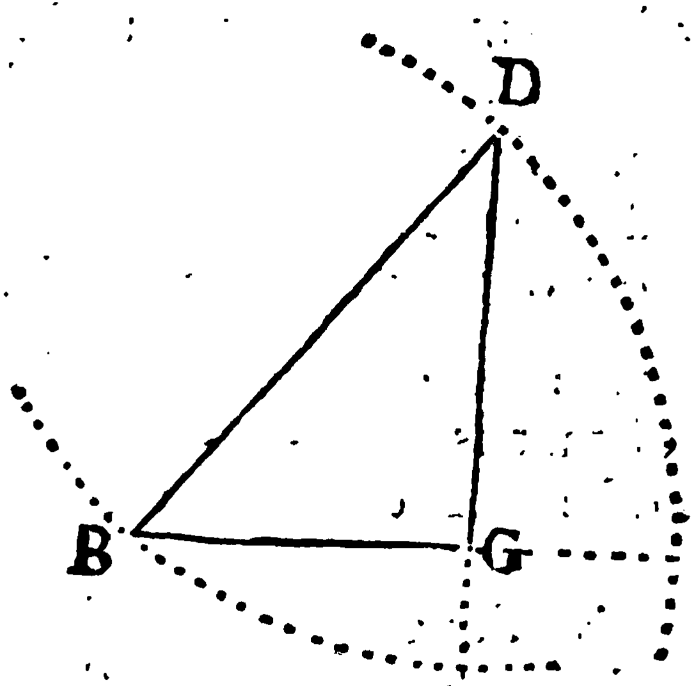
CASE 7.

The Hypothenuse and one of the Legs given, to find the other Leg.

Example. In the Triangle B G D, suppose the Leg B G, 87, and the Hypothenuse B D 142, requir'd the Leg D G.

Geometrically.

The Construction here is the same as in Case 5th the same things being given; and the Leg D G is



found by taking its length in your Compasses, and applying that to the same line of equal parts, the others were taken from.

By

By Calculation.

The Solution of this Case depends upon the 1*st* and 5*th*, and first we must find the Oblique Angles by Case 5*th* thus:

DB: BG:: R: S, D

i. e. as the Hypoth. DB - -	142	- - -	2.15229
is to the Leg BG - -	87	- -	1.93952
so is Radius - - - -	90°,	- -	10.00000
to the Sine of D - - -	37°, 47′	-	9.78723

Then by Case 1*st* we find the Leg DG requir'd thus:

R: S, B:: BD: DG.

i. e. as Radius - -	90°	- - - -	10.00000
is to the Sine of B -	52°, 13′	- -	9.89781
so is the Hypoth. DB	142	- - - -	2.15229
to the Leg DG -	112.2	- - -	2.05010

The Leg DG may also be found in the following manner, *viz.*

to the Log. of the Sum of the Hypothenuse and given Leg, *viz.* 229 -	2.35984
add the Log. of their difference, *viz.*-55--	1.74036
and their Sum is - - - - - - - - -	4.10020
the half of that is - - - - - - - -	2.05010

the Log. of 112.2 the Leg requir'd.

Or it may be done by taking the Square of the given Leg from the Square of the Hypothenuse, and the square Root of the Remainder is the Leg requir'd thus in the present Case:

the

the Square of the Hypothenuse 142, is - 20164
the Square of the Leg B G 87, is - - - 7569

the Difference of them is - - - - - 12595
whose Logarithm is - - - - - - 4.10020
and half of that Logarithm is - - - 2.05010

which answers to the Natural Number 112.2 the Leg requir'd.

Thus we have gone thro' the seven Cases of right-angled *Plain Trigonometry*, from which we may observe;

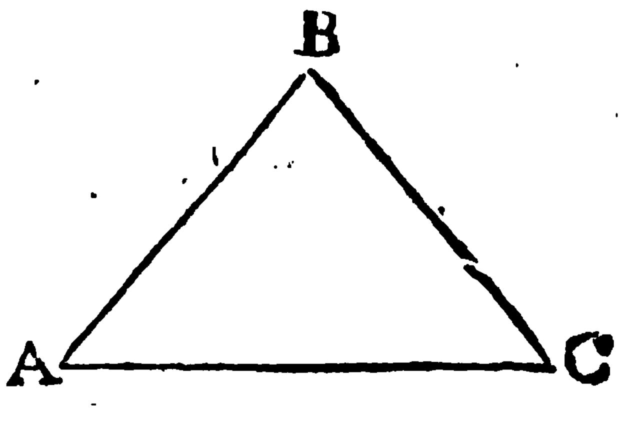
1. That to find a Side, when the Angles are given, any Side may be made the Radius.

2. To find an Angle, one of the given Sides must of necessity be made the Radius.

We now proceed to the Solution of the six Cases of Oblique-angled *Plain Trigonometry*, in order to which we must premise the following Theorems.

Theorem 1. In any Triangle, the Sides are proportional to the Sines of the opposite Angles. Thus in the Triangle ABC, I say AB : BC :: S, C : S, A and AB : AC :: S, C : S, B ; also AC : BC :: S, B : S, A.

Demonstration. Let the Triangle ABC be inscrib'd in a Circle; then 'tis plain, from *Art.* 66. *Sect.* 1. that the half of each side is the Sine of its opposite Angle, but (by *Art.* 72. *Sect.* 1.) the Sines of these Angles in Tabular Parts, are proportional to the Sines of the same in any other measure; therefore in the Triangle ABC, the Sines of the Angles will be as the halves of their opposite sides; and since the halves are as the wholes, it follows that the Sines of the Angles are as their opposite sides, *i. e.* S, C : S, A :: AB : BC, *&c.*

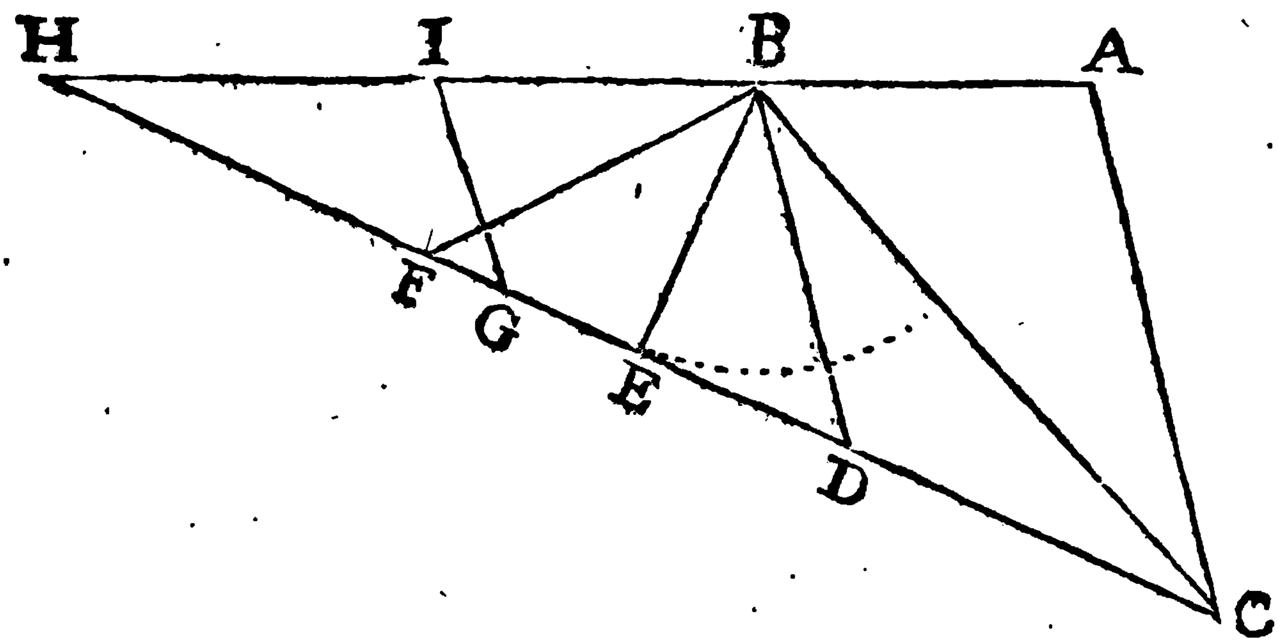


Theor. 2. In any plain Triangle, as ABC, the sum of the sides, AB and BC, is to the difference of these sides, as the Tangent of half the sum of the Angles at the base, *viz.* A and C, is to the Tangent of half the difference of these Angles.

Demon. Produce AB and make BH equal to BC, join HC and from B let fall the perpendicular BE, thro' B draw BD parallel to AC, and make HF equal to CD, and join BF, also take BI equal to BA, and draw IG parallel to BD or AC.

Then 'tis plain that AH will be the sum, and HI the difference of the sides AB and BC; and since HB is equal to BC, and BE perpendicular to HC, therefore HE is equal to EC; and BD being parallel to AC and IG, and AB equal to BI, therefore CD or HF is equal to GD, and consequently HG is equal to FD, and half HG is equal to half FD or ED. Again, Since HB is equal to BC, and BE perpendicular to HC, therefore the Angle EBC is half the Angle HBC; but (by *Art.* 60. *Sect.* 1.) the Angle HBC is equal to the sum of the Angles A and C, consequently the Angle EBC is equal to half the sum of the Angles A and C. Also since HB is equal to BC, and HF equal to CD, and the included Angles BHF, BCD equal, it follows (by *Art.* 62. *Sect.* 1.) that the Angle HBF is equal to the Angle DBC, which is equal to BCA (by *Art.* 36. *Sect.* 1.); and since HBD is equal to the Angle A (by *Art.* 37. *Sect.* 1.) and HBF equal to BCA, therefore FBD is the difference, and EBD half the difference of the two Angles A and BCA; so making EB the Radius, 'tis plain EC is the Tangent of half the sum, and ED the Tangent of half the difference of the two Angles at the Base. Now IG being parallel to AC, the Triangles HIG and HAC will be equiangular, consequently (by *Art.* 74. *Sect.* 1.) AH : IH :: CH : GH, but the wholes are as their halves, therefore

therefore AH : IH :: ½ CH : ½ GH ; and since ½ CH is equal to EC, and ½ GH equal to ½ FD equal ED, therefore AH : IH :: EC : ED. Now AH is the sum and IH the difference of the sides, also EC is the Tangent of half the sum, and ED the Tangent of half the difference of the two Angles at the Base ; consequently in any Triangle, as the sum of the sides, is to their difference, so is the Tangent of half the sum of the Angles at the Base, to the Tangent of half their difference.



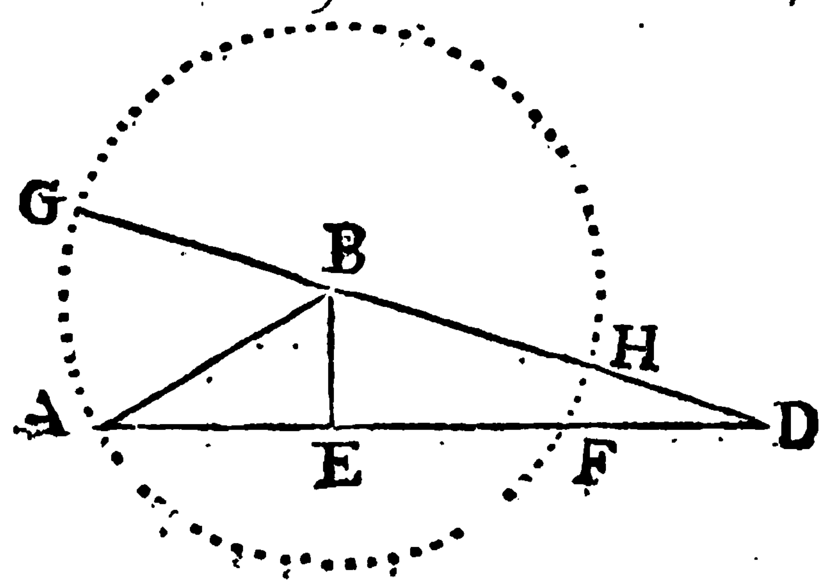
Theor. 3. If to half the sum of two Quantities be added half their difference, the sum will be the greater of them, and if from half their sum be subtracted half their difference, the Remainder will be the least of them.

Demon. Let the two Quantities be represented by the lines AB and BC (making one continued line) whereof AB is the greater, and BC the lesser. Bisect the whole line AC in E, and make AD equal to BC ; then 'tis plain AC is the sum and DB the difference of the two Quantities, and AE or EC their half sum, and ED or EB their half difference. Now if to AE we add EB, 'tis plain the sum will be AB, that is, if to half the sum we add the half difference, the sum will be the greater Quantity ; also if from EC we take EB, the Re-

mainder will be BC, that is, if from half the sum we take half the difference of two Quantities, the Remainder will be the least of them.

Theor. 4. In any right lin'd Triangle, ABD, the base AD is to the sum of the sides AB and BD, as the difference of the sides, is to the difference of the Segments of the base made by the perpendicular BE, *viz.* the difference between AE and ED.

Demon. Produce DB till BG be equal to BA the lesser Leg; and on B as a Center with the distance BA or BG describe the Circle AGHF, which will cut BD and AD in the points H and F; then 'tis plain, GD is the sum and HD the difference of the sides, also since AE is equal to EF (by *Art.* 64. *Sect.* 1.) therefore FD is the difference of the Segments of the base; but by *Art.* 75. *Sect.* 1, AD : GD :: HD : FD; therefore the base, is to the sum of the sides, *&c.* as was to be proved.



CASE I.

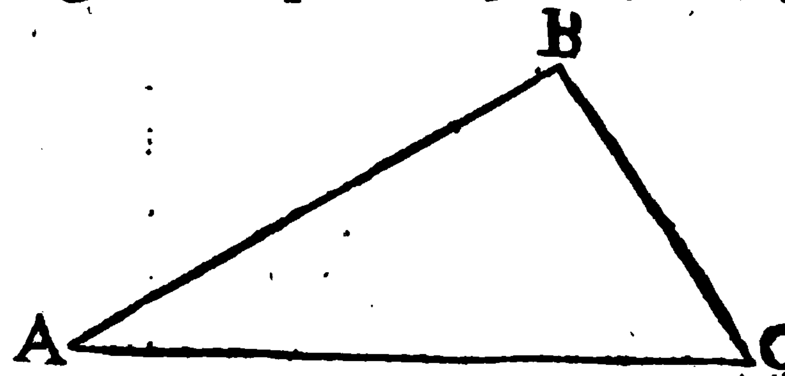
In any oblique-angled plain Triangle; two Sides, and an Angle opposite to one of them, given, to find the Angle opposite to the other.

Example,

Example. In the Triangle ABC, ſuppoſe AB 156, BC 84, and the Angle C, oppoſite to BA, 56°, 30′; requir'd the Angle A oppoſite to BC.

Geometrically.

Draw the line AC, and at any point of it, ſuppoſe C, make the Angle C equal to 56°, 30′ (by *Prob.* 10. *Sect.* 1.) take CB equal to 84; and with the Length of 156 (taken from the ſame line of equal parts with CB) in your Compaſſes, fixing one foot in B, with the other croſs AC in A. Laſtly join A and B; ſo the Triangle is conſtructed, and the requir'd Angle A may be meaſur'd by *Prob.* 11. *Sect.* 1.



By Calculation.

By *Theorem* 1. we have the following proportion for finding the Angle A. *viz.*

AB : S, C : : BC : S, A.

i. e. as the Leg AB - -	156° -	2.19312
is to the Sine of its oppoſite Angle C, 56°, 20′ - - - - - - - -		9.92111
ſo is the Leg BC - - -	84 -	1.92428
		11.84539
		2.19312
to the Sine of its opp. Angle A	26°, 41′	9.65227

CASE 2.

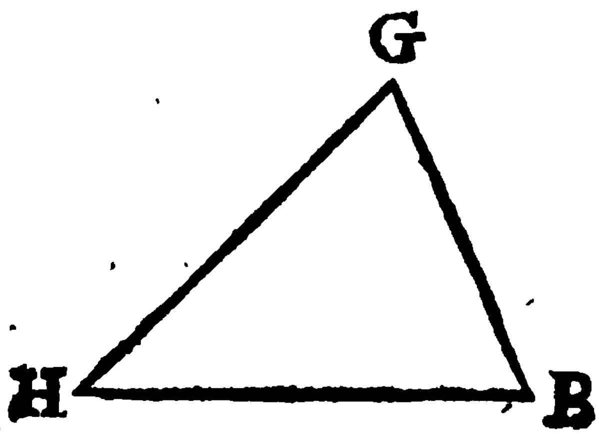
The Angles, and a Side oppoſite to one of them, given, to find a Side oppoſite to another.

Example.

Example. In the Triangle HBG, suppose the Angle H 46°, 15′, and the Angle B 54°, 22′, consequently the Angle G 79°, 23′, and the Leg HB 125, requir'd HG.

Geometrically.

Draw HB 125, from any Line of equal parts, and make the Angle H 46°, 15′, and B 54°, 22′, then produce the lines HG and BG till they meet one another in the point G; so the Triangle is constructed and HG is measured by taking its length in your Compasses, and applying it to the same line of equal parts that HB was taken from.



By Calculation.

By the first of the preceeding Theorems, we have this analogy for finding HG. *viz.*

S, G : HB : : S, B : HG.

i.e. as the Sine of G -	79°, 23′ -	9.99250
is to the Leg HB - -	125 - -	2.09691
so is the Sine of B- - -	54°, 22′ -	9.90996
to the Leg HG - - -	103.4 - -	2.01437

CASE 3.

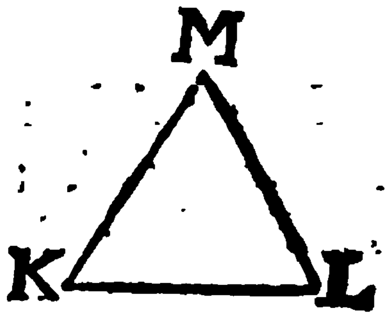
Two Sides and an Angle opposite to one of them given, to find the third Side.

Example. In the Triangle KLM, suppose the Side KL 126 equal parts, and KM 130 of these parts, and the Angle L (opposite to KM) 63°, 20′, requir'd the side ML.

Geometrically.

Geometrically.

The Geometrical Construction of this Case is the same with that in *Case* 1. (there being the same things given in both) and the Leg M L may be measur'd by applying it to the same line of equal parts that the other two were taken from.



By Calculation.

The Solution of this Case depends upon the two preceeding, and first we must find the other two Angles by *Case* 1. thus;

MK : S, L : : KL : S, M.

i. e. as the Side MK	- -	130	- -	2.11394
is to the Sine of L	- -	63°, 20′	-	9.95116
so is the Side KL	- -	126	- -	2.10037
to the Sine of M	- -	60°, 1′	-	9.93759

Then by *Case* 2. we find the requir'd Leg ML thus;

S, L : MK : : S, K : ML.

i. e. as the Sine of L	-	63°, 20′	-	9.95116
is to MK - - - - -	-	130	- -	2.11394
so is the Sine of K	- -	53, 39	-	9.90602
to ML - - - - -	-	117.2	-	2.06850

CASE 4.

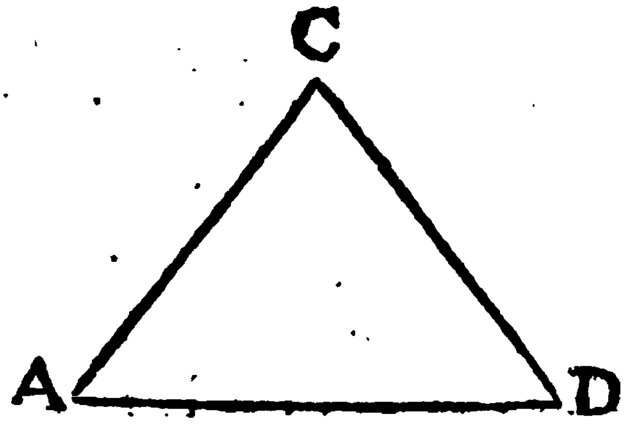
Two Sides and the Contain'd Angle given, to find the other two Angles.

Example.

Example. In the Triangle ACD, suppose AC 103, and AD 126, and the Angle A $54^{\circ}, 30'$, requir'd the Angles C and D.

Geometrically.

Draw AD 126 equal parts, and make the Angle A, $54^{\circ}, 30'$, then set 103 equal parts from A to C. Lastly, join C and D; and so the Triangle is con-



structed, and the Angles C and D may be measur'd by the line of Chords.

By Calculation.

The Solution of this Case depends upon the second and third of the preceeding Theorems; and first we must find the Sum and Difference of the Sides, and half the Sum of the unknown Angles. Thus,

the Leg AD is - - - - - - - - - - - -	126
the Leg AC is - - - - - - - - - - - -	103
their Sum is - - - - - - - - - - - -	229
and their Difference is - - - - - - - -	23
the Sum of the three Angles A, D and C is	180°
the Angle A is - - - - - - - - - -	$54^{\circ}, 30'$
so the Sum of the Angles C and D will be	125, 30
and half their Sum is - - - - - - -	$62^{\circ}, 45'$

then

Then by *Theorem* 2. we have the following Proportion, *viz.*

As the Sum of the Sides AD and AC 229 -- 2.35984
is to their Difference - - - - - 23 --- 1.36173
so is the Tang. of half the Sum of the unknown Angles - } 62°, 45′ -- 10.28816
to the Tang. of half their Diff. 11°, 2′ -- 9.29005

Now having half the Sum and half the Difference of the two unknown Angles C and D, we find the Quantity of each of them by *Theorem* 3. thus,

To half the Sum of the Angles C and D -	62°, 45′
add half their Difference - - - - - -	11 , 02
and the Sum is the greater Angle C -	73 , 47
Again from half the Sum - - - - - - -	62 , 45
take half the Difference - - - - - - -	11 , 02
and there will remain the lesser Angle D -	51, 43

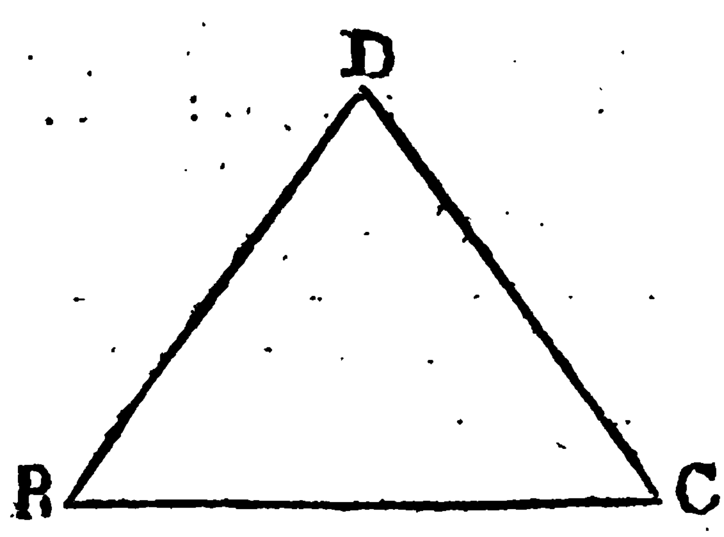
CASE 5.

Two Sides and the Contain'd Angle given, to find the third Side.

Example. In the Triangle BCD, suppose BC 154, and BD 133, and the Angle B 56°, 03′, requir'd the Side CD.

Geometrically.

The Geometrical Construction of this Case is the



same with that of the last, and the Length of DC

is found by taking its Length in your Compasses, and applying it to the same Line of equal Parts that the two Legs were taken from.

By Calculation.

The Solution of this Case depends upon the second and fourth; and first we must find the Angles by the last Case; thus,

As the Sum of the Sides BD and BC	287	2.45788
is to their Difference - - - - -	21	1.32222
so is the Tangent of half the Sum of the Angles D and C	61°, 58′	10.27372
to the Tangent of half their Diff.	7, 50	9.13806

So by *Theorem* 3. we have the Angles D and C thus,

to half the Sum of the Angles D and C -	61°, 58′
add half their Difference - - - - - -	7, 50
and the Sum is the greater Angle D - -	69, 48
Also, from half the Sum - - - - -	61, 58
take half the Difference - - - - - -	7, 50
and there remains the lesser Angle C -	54, 08

Then by *Case* 2. we have the following Analogy for finding DC the Leg requir'd, *viz.*

S, C : BD :: S, B : DC.

i. e. as the Sine of C -	54°, 08′	9.90869
is to BD - - - - - - -	133	2.12385
so is the Sine of B - -	56, 03	9.91883
to DC - - - - - - - -	136.2	2.13399

CASE

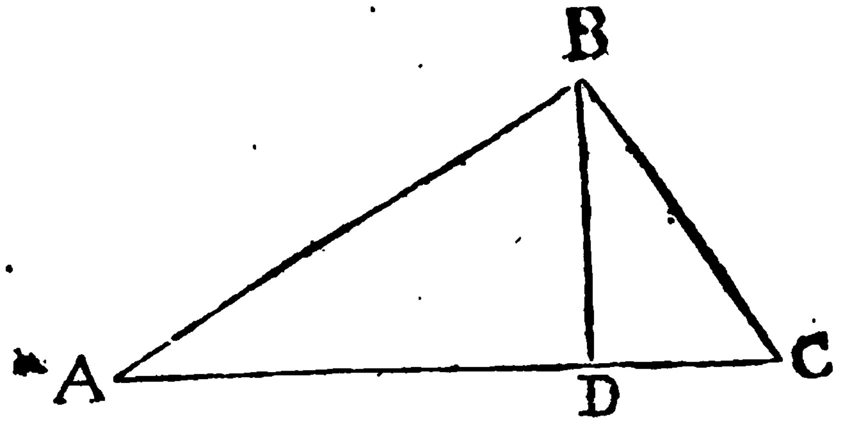
CASE 6.

Three Sides given, to find the Angles.

Example. In the Triangle ABC, ſuppoſe AB 156, BC 84, and AC 185.7; requir'd the Angles A, B, and C.

Geome rically.

Make AC 185.7 from any line of equal Parts, and from the ſame Line taking 156, the length of AB, in your Compaſſes, ſix one Foot of them in A, and with the other ſweep an Arch; then take 84, the Length of BC, and fixing one Foot in C,



with the other ſweep an Arch, which will croſs the former in B; laſtly join the Points BA and BC, ſo the Triangle will conſtructed, and the Angles may be meaſur'd by the line of Chords.

By Calculation.

Let fall the Perpendicular BD from the Vertex B, upon the Baſe AC, which will divide the Baſe into the two Segments AD and DC, and to find the Lengths of theſe, we have, by *Theorem* 4. the following Proportion, *viz.*

As the Base AC - - - - - - -	185.7 - -	2.26893
is to the sum of the sides AB & BC	240 - -	2.38031
so is the Difference of the Sides -	72 - -	1.85733
to the Diff. of the Segments of the Base	93 - -	1.96871

And having the Sum of the Segments, *viz.* the whole Base, and their Difference, we find the Segments themselves, by *Theorem* 3. thus,

To half the Sum of the Segments - - - -	92.8
add half their Difference - - - - - - - -	46.5
and the Sum is the greater Segment AD -	139.3

Also from half the Sum of the Segments -	92.8
take half their Difference - - - - - - -	46.5
the Remainder is the lesser Segment DC -	46.3

Now the Triangle ABC is divided, by the Perpendicular DB into two Right-angled Triangles, ADB, and DBC; in the first of which are given the Hypothenuse AB 156, and the Base AD 139.3 to find the oblique Angles, for which we have (by *Case* 5. of Rectangular Trigonometry) the following Analogy, *viz.*

As AB - - - - - - - - - -	156 -	2.19312
is to AD - - - - - - - - -	139.3 -	2.14395
so is the Radius - - - - - - -	90° -	10.00000
to the Co-Sine of the Angle A	26°, 40′ - -	9.95083

Also the Angle C is found by the same Case, thus,

As BC - - - - - -	84 - - - - -	1.92428
is to CD - - - - -	46.3 - - - - -	1.66558
so is the Radius - -	90° - - - -	10.00000
to the Co-Sine of C	56°, 30′ - - - -	9.74130

Having

Having found the two Angles A and C, we have the third, B, by taking the Sum of the other two from 180, thus,

The Sum of all the three Angles is -	180°	
the Sum of A and C is - - - - -	83	10
the Angle B is - - - - - - - - - -	96	50

All the Proportions us'd for the Solutions of the several Cases in *Plain Trigonometry*, may be perform'd by the Scale and Compass. On the Scale there are several Logarithmic Lines, *viz.* one of Numbers, another of Sines, and one of Tangents, *&c.* And the way of working a Proportion by these is this, *viz.* Extend your Compasses from the first Term of your Proportion, found on the Scale, to the second, and with that Extent, fixing one Foot in the third Term, the other will reach the fourth Term requir'd.

SECT. III.

Of the Principles of GEOGRAPHY *and* ASTRONOMY.

1. THE Land and Water of this Earth make up a Composition of a Spherical Form, or rather an oblong Figure, which is call'd the *Terraqueous Globe.*

2. This Globe moves round its Axis in 24 Hours, from West to East; and thereby causing the Celestial Bodies to revolve, apparently from East to West, in the same time, makes the Vicissitudes of Day and Night.

3. These

3. These two Points in which the Axis of the Earth meets the Surface, are call'd the Poles of the Earth; and if the Axis be produc'd on both Sides, to the Heavens, it will cut them in two opposite Points call'd the *Celestial Poles.* The one towards the North, is called the *Artic Pole*; and the other towards the South, the *Antarctic.*

4. Circles upon a Sphere, are either Great or Lesser. A *Great Circle*, is that whose Plain passes through the Center of the Sphere, or whose Diameter is equal to the Diameter of the Sphere. A *Lesser Circle* is that whose Plain does not pass thro' the Center of the Sphere, or whose Diameter is less than the Diameter of the Sphere.

Cor. 1. Hence it is plain, that all great Circles upon a Sphere divide it into Halves, and all lesser Circles divide it unequally.

Cor. 2. And since all great Circles have the same Center, *viz.* that of the Sphere, it is plain they must bisect one another.

5. Since the Earth moves round it's Axis, 'tis plain that every Point in the Surface (except the two Poles which are at Rest) will describe the Circumference of a Circle; and that which is describ'd by a Point lying in the middle between the two Poles, is call'd the *Equator*, or *Equinoctial Line*, or simply the *Line.*

6. If the Plain of the Equator be produc'd to the Heavens, it will there mark out a Circle call'd the *Celestial Equator*, which will divide the Earth and Heavens into two Hemispheres, that towards the North call'd the *Northern Hemisphere*, and that towards the South, the *Southern.*

7. Great Circles passing through the Poles of the World, and cutting the Equator at Right Angles, are call'd *Meridians*; and that which passes over any Place, is call'd the Meridian of that Place.

8. The

8. The Diſtance of any Place upon the Earth, from the Equator, counted in Degrees upon the Meridian, is call'd the *Latitude* of that Place; and it is either North or South, according as it lies upon the North or South Side of the Equator.

9. Since by the Rotation of the Earth about it's Axis, every Point upon it's Surface deſcribes a Circle, 'tis plain all the Points between the Equator and Poles, muſt deſcribe Circles parallel to the Equator; and theſe are called *Parallels of Latitude.*

10. The *Difference of Latitude* between two Places, is the Arch of a Meridian, contain'd between the Parallels of Latitude paſſing over theſe Places.

Cor. 1. Hence if the two Places lie both on the ſame Parallel, they will have no Difference of Latitude.

Cor. 2. If the Places lie both on the ſame Side of the Equator, and on different Parallels, then their Difference of Latitude is found by taking the leſſer Latitude from the greater.

Cor. 3. But if the Places lie on different ſides of the Equator, then their Difference of Latitude is equal to the Sum of the two Latitudes.

11. The *Compliment of the Latitude* of any Place, is that Latitude taken from 90 Degrees, or the Diſtance of the Place from the neareſt Pole.

12. The *Longitude* of any Place upon the Earth, is an Arch of the Equator intercepted between the firſt Meridian, and the Meridian paſſing thro' the propoſed Place. Which is equal to the Angle at the Pole formed by the firſt Meridian and the Meridian of the Place.

13. The firſt Meridian may be placed at Pleaſure, paſſing thro' any Place; as *London*, *Paris*, *Treneriff*, &c. and the Longitudes counted from it will be either Eaſt or Weſt according as they lie on the Eaſt or Weſt ſide of that Meridian.

14. The

14. The *Difference of Longitude* between two Places upon the Earth, is an Arch of the Equator comprehended between the two Meridians of these Places, and the greatest possible is 180 Degrees, *viz.* when the two Places lie on opposite Meridians.

15. Since by the Motion of the Earth about it's Axis every point upon the Surface, describes the Circumference of a Circle or 360 Degrees, in 24 Hours time, 'tis plain in one Hour it must describe 15 Degrees; therefore any Place lying 15 Degrees to the Eastward of another, has the Sun upon its Meridian 1 Hour sooner than that other; so when it is Twelve a Clock in the eastermost Place, it will be but Eleven in the other.

Cor. Hence the difference of Longitude may be converted into difference of Time, by allowing 1 Hour for every 15 Degrees, and proportionally for Minutes, &c. also difference of Time may be converted into difference of Longitude, by allowing 15 Degrees for every Hour, and proportionally for other Time. Consequently by knowing the one, we can find the other.

16. If we suppose a Plain touching the Surface of the Earth in any Point, (upon which a Spectator is standing) and produced to the Heavens, it will there make a Circle called the *Horizon*, which separates the Visible from the Invisible Part of the Heavens. This Horizon is properly the *sensible Horizon*; the *true* or *rational Horizon* is a great Circle parallel to the sensible, and passing thro' the Center of the Earth, which divides the Heavens and Earth into two Halves, called the *Upper* and *Lower Hemispheres*.

17. These two Horizons when produced to the Heavens, may, without any sensible Error, be supposed to coincide the Distance between them, or the Earth's Semidiameter, vanishing when compared with such a Distance.

18. Since

18. Since the Earth moves round its Axis from West to East, 'tis plain a Spectator upon its Surface, together with his Horizon, must move the same way; consequently these Celestial Bodies towards the East, that were before inconspicuous will become visible, the Horizon being depressed below them; and these towards the West, that were before in view, will become invisible, the Horizon being elevated above them. And hence arises the apparent Motion of all the Heavenly Bodies, by which they appear to describe Circles round the Poles, parallel to the Celestial Equator, which are greater or less according as they are more or less distant from the nearest Pole.

19. When any Celestial Body comes first in view, or when it is on the eastern side of the Horizon, it is then said to *Rise*; and when by its apparent Motion it comes to the Meridian, it is said to *Culminate*; and lastly, when it begins to disappear, or is upon the western side of the Horizon, it is then said to *Set*.

20. If through the Center of the Earth there be drawn a Line perpendicular to the Plain of the Horizon, and produc'd to the Heavens, it will there mark out two Points; the one, which is directly over our Heads, is call'd the *Zenith*; and the opposite Point thereto, which is invisible to us, *viz.* directly under our Feet, is call'd the *Nadir*.

21. *Vertical* or *Azimuth Circles*, are great Circles passing thro' the Zenith and Nadir, and cutting the Horizon at right Angles. Among the Vertical Circles there are two principal ones, *viz.* the Meridian, which passes thro' the Zenith, Nadir, and Poles, and cuts both the Equator and Horizon at right Angles; the points in which it cuts the Horizon are the South and North Points; and the other principal Vertical, call'd the *prime Vertical*, is that which cuts the Meridian at right Angles, and meets the

L Hori-

Horizon in two oppoſite points, call'd the Eaſt and Weſt points.

22. Leſſer Circles parallel to the Horizon are call'd *Almicanthers*, or *Parallels of Altitude*. And theſe continually decreaſe the nearer they are to the Zenith.

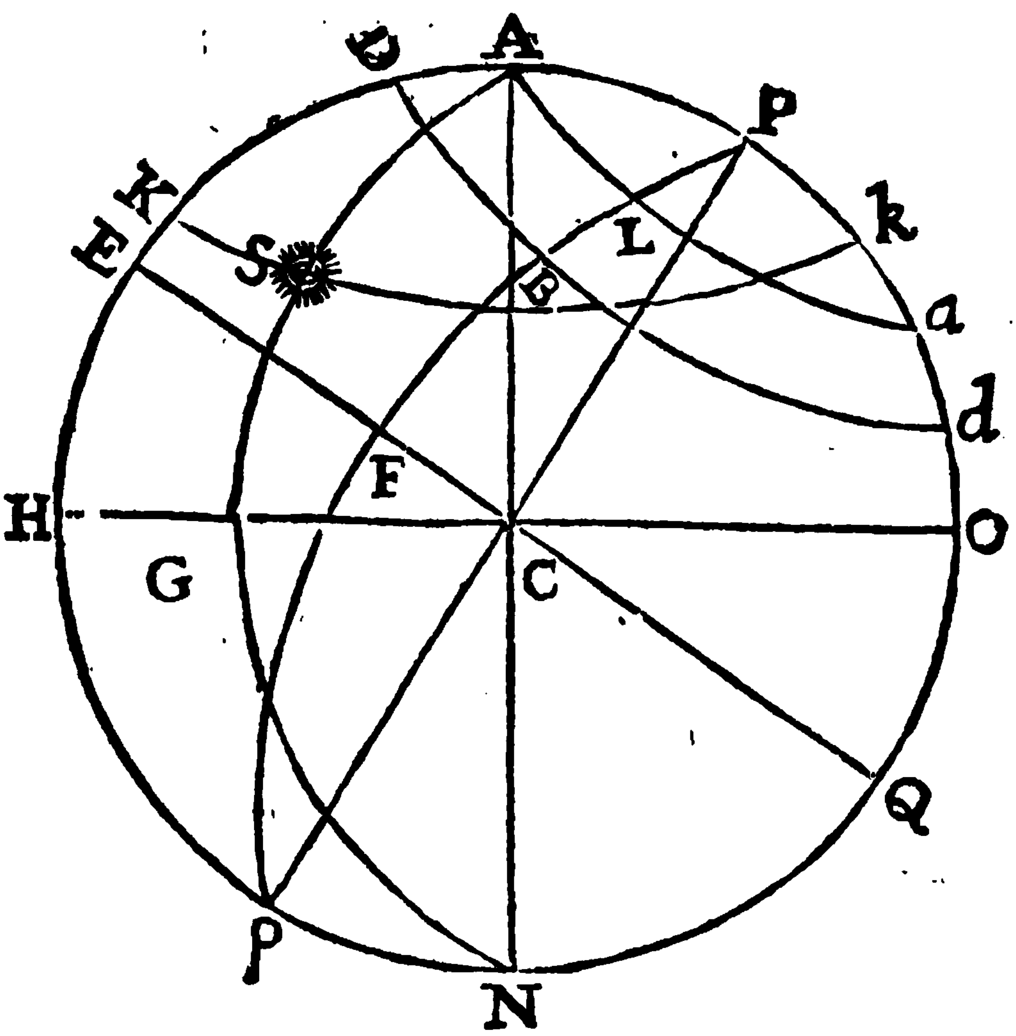
24. The *Altitude*, or Depreſſion of any heavenly Body above or below the Horizon, is an Arch of a Vertical Circle intercepted between the Horizon and Center of the Object.

25. The *Zenith Diſtance* of any heavenly Object, is that Arch of the vertical Circle paſſing through it, intercepted between the Center of the Object and the Zenith, which is always the Compliment of the Altitude.

26. Let the Circle A H N O repreſent the Earth, projected on the plain of ſome Meridian, A ſome place upon that Meridian; draw the Diameter H O at a Quadrant, or 90 Degrees, diſtance from A; then HO will repreſent the Horizon of the Place A (by *Art.* 16. of this). Let P and *p* be the two Poles; conſequently P*p* the Axis of the Earth, and the Diameter E Q at right Angles with that will repreſent the Equator, (by *Art.* 5.) make P *a* equal to P A, and draw the Circle A *a* parallel to the Equator E Q, and this will be the parallel of Latitude the place A lies on. The Arch AE will be the Latitude of the place A, and A P, the Compliment of it's Latitude (by *Art.* 8. and 11.) the Point in the Heavens directly above A will be the Zenith, and that directly above N will be the Nadir of the Place A (by *Art.* 20.) the great Circle ACN will be the prime Vertical (by *Art.* 21.) and the Points H and O will be the South and North Points, and C will repreſent the Eaſt and Weſt Points in the Horizon of A. Let S be any heavenly Object, and A S N a vertical or azimuth Circle paſſing thro' the Cen-

ter

ter of the Object; also KS it's parallel of Altitude; then SG will be the Altitude and SA the Zenith Distance of the Object S (by *Art.* 24. and 25.). A-

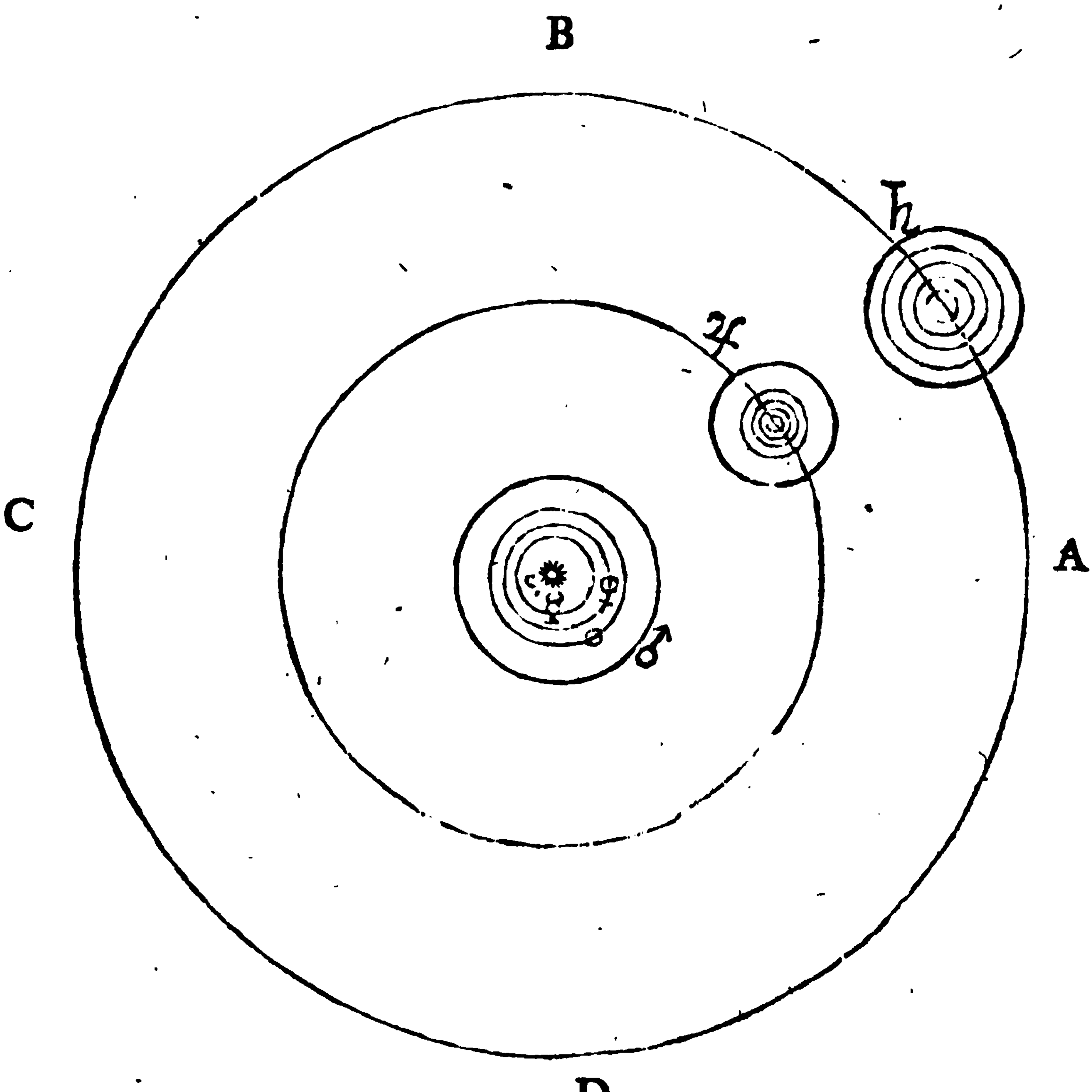


gain, let any other place upon the Earth be assum'd, as B, and its Meridian will be PB*p*, and its parallel of Latitude DB*d*; then the Latitude of B will be BF or DE, and the Compliment of it's Latitude will be BP or DP. Also the difference of Latitude between the two places A and B, will be BL or DA (by *Art.* 10.). If the Meridian passing thro' A, be suppos'd the first Meridian, then the Longitude of B will be EF (by *Art.* 12.) but if the Meridian of A be not suppos'd the first Meridian, then the difference of Longitude between the two Places A and B will be EF (by *Art.* 14.).

27. The System of the Universe according to the latest Astronomers is as follows, *viz.* The *Sun*

 is

is ſuppos'd to be in the common Center of Gravity, of ſix opake ſpherical Bodies called *Planets*, which are at different diſtances from the Sun, and and perform their ſeveral Periods round him in different Times; the names of theſe Planets and the Characters by which they are expreſs'd, are as follows, *viz.* *Mercury* ☿, *Venus* ♀, the Earth ⊖,



Mars ♂, *Jupiter* ♃, and *Saturn* ♄. And they all move round the Sun, from Weſt to Eaſt, in Orbs very little inclin'd to one another, and the Plains of theſe Orbs cut one another in Lines paſſing through the Center of the Sun; conſequently a Spectator

Spectator plac'd in the Center of the Sun, will be in the Plain of each of their Orbs, and will there view the Planets, performing their ſeveral Periods round him, from Weſt to Eaſt, according to the order of the Letters ABCD, (in the annex'd Scheme) and in different Times, *viz.* *Mercury* ☿, which is neareſt the Sun, moves round his Orb in 87 Days, and 23 Hours, or three Months nearly. Then *Venus* ♀, which is next to *Mercury*, performs her Period in 224 Days and 17 Hours, or about 8 Months. The Planet which is third in order from the Sun, is our Earth ⊖, which performs its Circuit in 365 Days, 5 Hours, and 49 Minutes, or a Year. Next to the Earth is *Mars* ♂, who moves round his Orb in 686 Days and 23 Hours, or a little leſs than 2 Years. Then *Jupiter* ♃, whoſe Orb is vaſtly extended beyond that of *Mars*, performs his Circuit in 4332 Days, 12 Hours, which is about 12 Years. And laſtly *Saturn* ♄, who is furtheſt diſtant from the Sun, compleats his Revolution in 10759 Days, and 7 Hours, which is ſomething leſs than 30 Years. Their diſtances from the Sun expreſs'd in the Scheme, are nearly proportional to their true diſtance in the Heavens.

28. Three of the Planets, *viz.* *Mars*, *Jupiter*, and *Saturn*, whoſe Orbs are beyond that of the Earth, are called *ſuperior Planets*; and the two Planets *Venus* and *Mercury*, whoſe Orbs are between the Earth's Orb and the Sun, are called the *inferior Planets*.

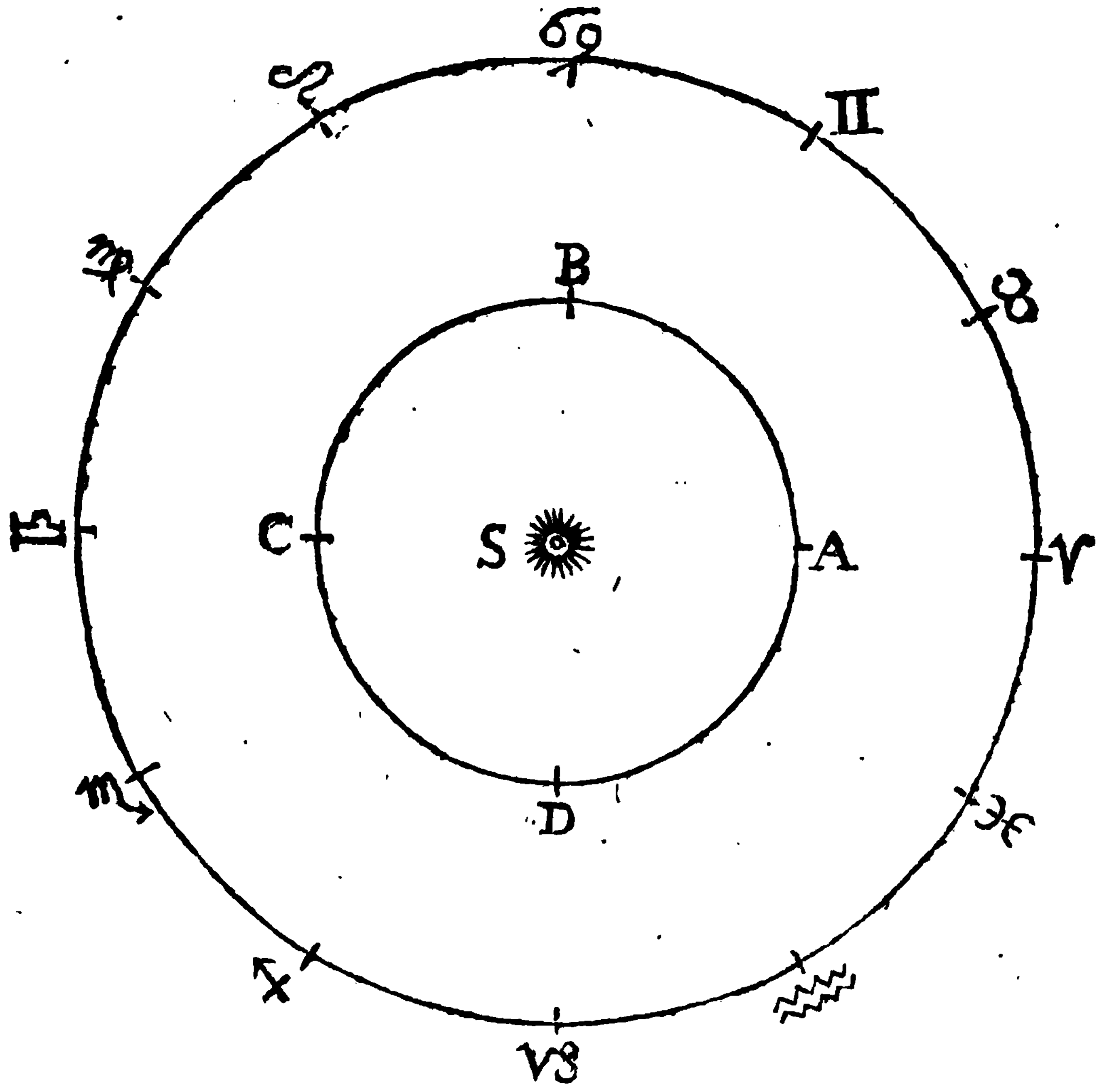
29. The three Planets, *Jupiter*, *Saturn*, and the Earth, are obſerved to have other ſmaller ones conſtantly attending them, called *Secondary Planets*, or *Satellites*. Theſe Satellites always attend their reſpective Primaries in their Revolutions about the Sun, and at the ſame Time they are conſtantly moving about them; the Earth has one, *viz.* the *Moon*,

Moon, which attends it in it's annual Revolution about the Sun, and at the same Time moves round it as a Center, in about 27 Days, and 7 Hours. *Jupiter* has four Satellites attending him, which are at different Distances from him, and move round him in different Times, *viz.* that which is innermost or nearest, his Body revolves in 1 Day 18 Hours; the next describes it's Orbit in 3 Days and 13 Hours; the third moves round in 7 Days and 3 Hours; and that which is furthest from *Jupiter's* Body, performs it's Circuit in 16 Days and 18 Hours. *Saturn* has five Satellites moving round him as a Center, which are at different Distances from his Body, and perform their Revolutions in different Times, *viz.* the first or nearest to him, performs it's Circuit in 1 Day, 21 Hours; the second, in 2 Days, 17 Hours; the third, in 4 Days 13 Hours; the fourth, in 15 Days, 22 Hours; and the fifth, or the most remote from the Body of *Saturn*, compleats it's Revolution in 79 Days and 8 Hours.

30. The *fix'd Stars* are suppos'd to be of the same matter with the Sun, and made for the same Ends, *viz.* each of them the Center of it's own proper System, having Planets moving round it as our Sun has.

31. Having given a cursory View of the System of the Universe, we shall now consider the Motion of the Earth, a little more particularly. Let S represent the Sun in the Center, ABCD the Orbit of the Earth, and ♈ ♋ ♎ ♑ the Heaven of the fix'd Stars; then if the Observer be suppos'd to be plac'd in the Sun at S, 'tis plain when the Earth is in the point A of it's Orbit, it will appear to be at the fix,d Star ♈, and while in moving from West to East, it goes from the point A of it's Orbit to B, it will appear to the Observer at S to pass by the

the fix'd Stars ♈ ♉ ♊ ♋; and in moving from B to C, it will appear to pass by the fix'd Stars



♋ ♌ ♍ ♎; and from C to D, the fix'd Stars ♎ ♏ ♐ ♑; and from D to A the fix'd Stars ♑ ♒ ♓ ♈. Again let the Observer be remov'd from the Sun to the Earth, then 'tis plain when the Earth is in the point A of it's Orbit, the Sun S will appear to be in the opposite point of the Heavens, *viz.* at the fix'd Star ♎; and while the Earth is moving in it's Orbit from A to B, the Sun will appear to pass by the fix'd Stars ♎ ♏ ♐ ♑; also while the Earth moves from B to A, the Sun will appear to have mov'd from ♑ by the fix'd Stars ♒ ♓, *&c.* to ♎; consequently the

the Sun to an Inhabitant of the Earth, will appear to paſs over the ſame fix'd Stars, and towards the ſame part of the Heavens, *i.e.* from Weſt to Eaſt, as the Earth appear'd to an Obſerver in the Sun.

32. Hence ariſes the apparent Motion of the Sun from Weſt to Eaſt. So that if any fix'd Star be obſerv'd to riſe with the Sun; ſome Days after, the Sun will have mov'd more eaſterly, and the Star will riſe before the Sun, and alſo ſet before it: alſo if a Star, in or near the Path which the Sun appears to deſcribe in his annual Motion, and at ſome diſtance from the Sun, be obſerv'd above the Horizon after Sun-ſet, it will ſome time after that appear to ſet with the Sun, and for a while, will not be viſible at Night.

33. The ſame way the Sun will appear to an Obſerver in any of the other Planets to move from Weſt to Eaſt, and to deſcribe the ſame Orbit in the Heavens that the Planet would appear to do to an Obſerver in the Sun.

34. The Circle in the Heavens that the Earth to an Obſerver in the Sun, or the Sun to an Obſerver in the Earth, appears to deſcribe is called the *Ecliptick*, and it is divided into twelve equal Parts called *Signs*, each containing 30 Degrees, *viz.* the $\frac{1}{12}$ of 360. The Names and Characters by which theſe Signs are uſually expreſs'd, are as follows.

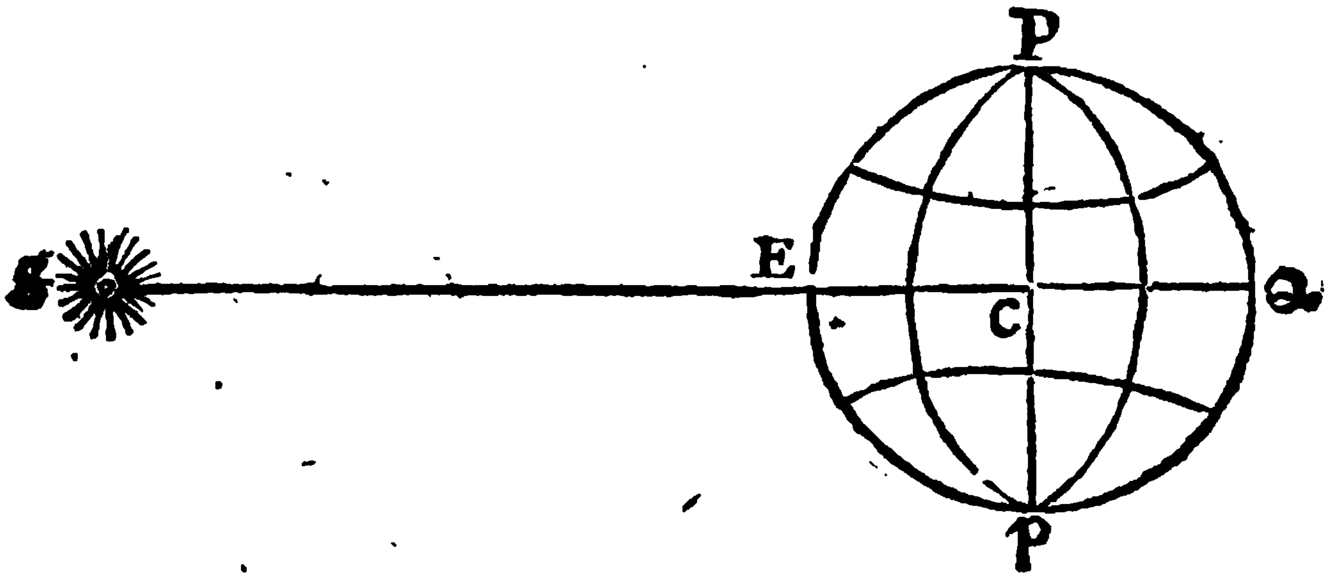
♈	♉	♊	♋	♌	♍	♎
Aries,	*Taurus*,	*Gemini*,	*Cancer*,	*Leo*,	*Virgo*,	*Libra*,

♏	♐	♑	♒	♓
Scorpio,	*Sagittarius*,	*Capricornus*,	*Aquarius*,	*Piſces.*

35. Since the Earth is a ſpherical Body expoſed to the Rays of the Sun, 'tis plain half of it's Body muſt be enlightned, while the other half is in darkneſs; and if there be a Line drawn from the Center

ter of the Sun to that of the Earth, and a plain perpendicular to that Line paſſing thro' the Center of the Earth; then this Plain will cut the Earth in a great Circle, which will ſeparate the enlightned from the darkned Hemiſphere; and this Circle is called the *Terminator* of Light and Darkneſs upon the Earth.

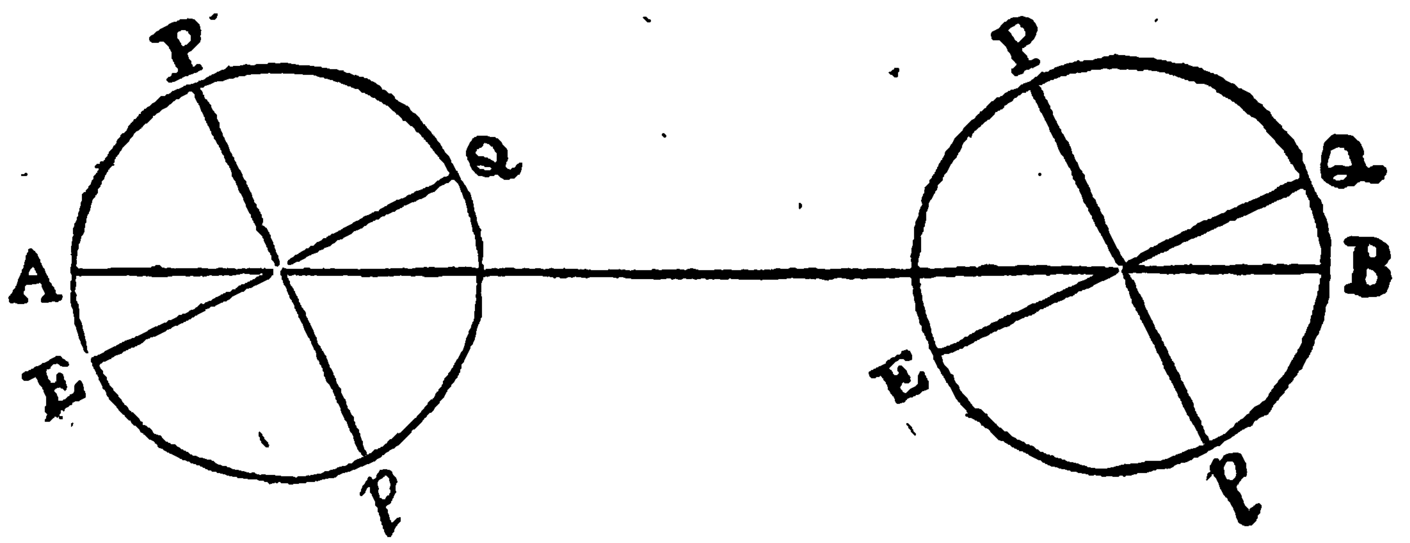
36. If the Plain of the Earth's Equator lay in the Plain of the Ecliptick, and conſequently the Earth's Axis were perpendicular to the Ecliptick, then the Terminator of Light and Darkneſs would be a Meridian; for let the Circle P E *p* Q repreſent the Earth, P and *p* it's two Poles, E Q the Equator, C the Center of the Earth, and S the Sun laying in the ſame Plain with E Q; then, by the laſt Article, the Terminator muſt be perpendicular to SC, and conſequently, in this Caſe, to the plain of the Equator E Q; but ſince all great Circles perpendicular to the Equator muſt paſs thro' the Poles, and ſo be Meridians; it follows that in this Caſe the Terminator muſt be a Meridian, as P *p*. And ſince all Meridians biſect the Equator (by *Art.* 4. *Cor.* 2. of this) they muſt alſo biſect it's Parallels,



conſequently the Terminator which is here a Meridian, muſt biſect the Equator and all it's Parallels;

ſo the half of each Parallel muſt be always enlightned, and the other half in Darkneſs; and ſince by the Motion of the Earth about it's Axis, every point upon it's Surface, except the Poles, deſcribes a Circle parallel to the Equator; it plainly follows that if the plain of the Equator lay in the plain of the Ecliptick, every point upon the Earth's Surface, except the two Poles, would have the Sun as long above it's Horizon as below it, and ſo there would be a conſtant equality of Day and Night, *viz.* 12 Hours each; and the two Poles would have the Sun conſtantly moving round their Horizon.

37. The Axis of the Earth is obſerv'd to be inclin'd to the plain of the Ecliptick at an Angle of about 66½ Degrees, and conſequently the plain of the Equator muſt be inclin'd to the Ecliptick, at an Angle of 23½ Degrees, *viz.* the Compliment of the former. Alſo the Axis of the Earth in it's annual Motion about the Sun, keeps always parallel to the ſame Line; ſo if there be a Line drawn thro' the Center of the Sun, parallel to the Earth's Axis, while in any point of its Orbit, that Line will continue parallel to the Axis, whatever point of the Orbit, the Earth be in (at leaſt in a Year's



time the Difference is inſenſible). And this muſt neceſſarily happen, if the Earth had no other Motion

tion but a progressive one in it's Orbit, and a rotation about it's Axis. For suppose any spherical Body as PE pQ, whose Center moves along the Line AB, and while in A, let any Diameter of it as Pp, be assum'd, inclin'd any way to the Line AB; then 'tis plain if the Body had no other but the progressive Motion, when it has come to B, the Diameter Pp will still be parallel to it's former Situation while in the point A; and if the same Body be suppos'd also to move round it's Axis Pp, 'tis plain all parts of it would consequently be changing their Situations, except the Axis which is no way affected by the rotation, and consequently the Axis must always keep parallel to the same right Line.

38. Since the plain of the Equator is inclin'd to the plain of the Eclip̄tick, therefore they must intersect one another in a right Line passing thro' the Centers of the Earth and Sun, and so the plain of the Eclip̄tick must cut the Earth in a great Circle, which will be inclin'd to the Equator at an Angle of 23½ Degrees, and this will mark out upon the Earth's Surface, the path of the Sun in his annual Motion; the Line in which the Equator intersects the Ecliptick, must always be parallel to the same Line, whatever point of the Orb the Earth be in; for since (by the last *Art.*) the Earth's Axis always preserves a Parallelism, and that Line being always inclin'd to the Axis at the same Angle, 'tis plain therefore, that it must also keep a constant Parallelism.

39. If thro' the Center of the Sun, there be drawn a Line perpendicular to the plain of the Ecliptick; then this Line is called the Axis of the *Ecliptick*, and the two opposite Points in which the Axis meets the Heavens, are called the *Poles of the Ecliptick.*

 40. That

40. That great Circle in the Heavens which passes thro' the Poles of the World and the points of Intersection, of the Ecliptick and Equator, is called the *Equinoctial Colure.* And that great Circle which is at right Angles with the former, and passes thro' the Poles of the Ecliptick and World, is called the *Solstitial Colure.* The four Points in which these Colures cut the Ecliptick, are called the *Cardinal Points.* These two in which the equinoctial Colure meets the Ecliptick, are called *Equinoctial Points*; because (as shall be shewn) when the Sun is in either of them there is an equality of Day and Night to the Inhabitants of the Earth; and the two Points in which the solstitial Colure cuts the Ecliptick, are called the *Solstitial Points*; because when the Sun comes to either of these Points, he is then at his greatest Distance from the Equator, and is beginning to return to it again.

41. To explain the Phenomena, or Appearances that arise from the Earth's annual Motion about the Sun: suppose ♑ ♈ ♋ ♎ the Earth's Orbit, and S the Sun; thro' S draw the right Line ♎ S ♈, parallel to the common Line of Intersection, of the Ecliptick and Equator, and meeting the Ecliptick in the two Points ♈ and ♎; also thro' S draw the Line ♑ S ♋ perpendicular to the former; then, 'tis plain when the Earth is in the Point ♎ of it's Orb, the Line S ♎, joining the Centers of the Sun and Earth, will coincide with the common Intersection of the Ecliptick and Equator, and so lie in the plain of the Equator, and consequently be perpendicular to the Earth's Axis; and since (by *Art.* 35.) this Line is also perpendicular to the Terminator of Light and Darkness, 'tis plain that the Axis of the Earth will lie in the plain of the Terminator, which therefore must pass thro' the two Poles, and so be a Meridian; also the Sun will appear in the opposite point of the Orbit at ♈, *viz.* in the Line

♎ S

♎ S produc'd, that is, in the plain of the Equator; and consequently by his apparent daily Motion, he will describe the celestial Equator. And since in this situation of the Earth, the Terminator of Light and Darkness is a Meridian, it will bisect the Equator and it's Parallels; consequently the half of each parallel will be in the enlightned Hemisphere, and the other half in the darkned; and every point upon the Surface of the Earth, describing, by it's daily Motion, either the Equator or some of it's Parallels; it plainly follows, that when the Earth is in the Point ♎ of it's Orb, each place upon it's Surface, will be as long in the enlightned Hemisphere as in the darkned, *i. e.* there will be an equality of Night and Day (*viz.* 12 Hours each) over all the Earth, except at the two Poles, where the Sun will appear to describe the Horizon of each, *viz.* the Equator.

The Earth, by it's annual Motion being carried along the Signs ♏ ♐, the Line of Intersection of the Ecliptick and Equator remaining always parallel to itself, it cannot now be directed towards the Sun; but when the Earth is in the first Point of ♑, it must make with the Line S ♑, joining the Centers of the Earth and Sun, a right Angle. And since the Line S ♑ is not in the plain of the Equator, but of the Ecliptick, the Angle B ♑ S, that the Axis of the Earth AB makes with S ♑, will be acute, equal to 66½ Degrees, *viz.* the Inclination of the Axis of the Earth to the Ecliptick. Thro' the Center of the Earth ♑, draw the Circle F L, perpendicular to S ♑, and this will be the Terminator of Light and Darkness, (by *Art.* 35.) and the Arch B L will be 23½ Degrees, *viz.* the Compliment of L B. Thro' the Center ♑, draw the Circle Q E perpendicular to the Axis A B, and this will be the Equator; then since the Arch E B is equal to the Arch T L, (being each a Quadrant) by tak-

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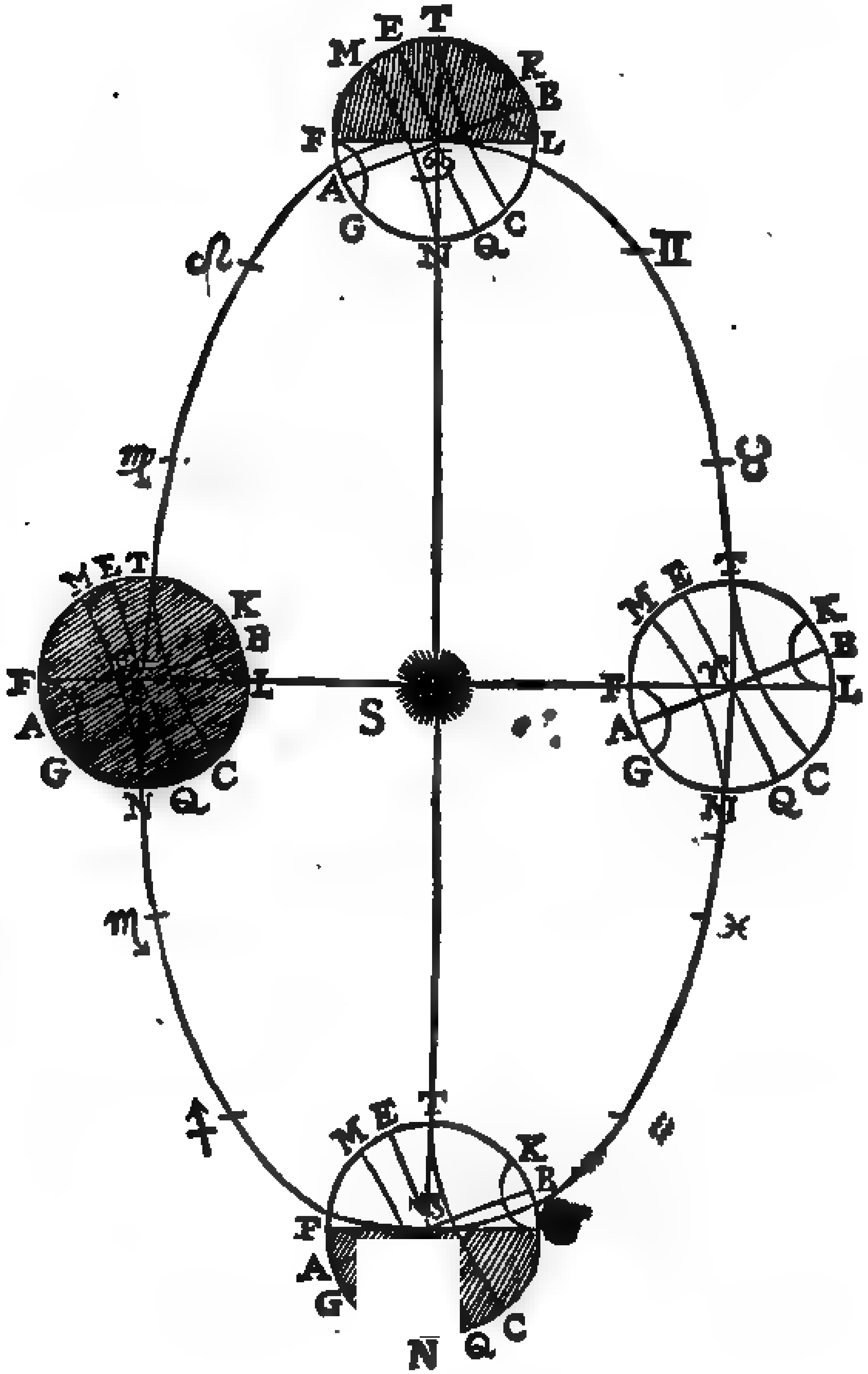
ing away the common Arch TB, we have ET



equal to BL, *i. e.* 23½ Degrees. Make the Arch

EM

EM equal to ET, and thro' the points T and M draw the Circles TC, MN parallel to the Equator; then 'tis plain that when the Earth is in the point ♑ of it's Orbit, the Sun will be perpendicular to the point T, distant from the Equator EQ, towards the North Pole B, 23½ Degrees, which is his greatest Declination North. The parallel TC is called the *Tropick* of *Cancer*, and the Circle in the Heavens concentric with this, which the Sun appears to describe at that time, is called the *Celestial Tropick* of *Cancer*; because the Sun at that time appears to be in the Sign ♋. And because of the Earth's rotation about it's Axis, 'tis plain that all the Points situate upon the parallel TC, will have the Sun, when upon their Meridian, in their Zeniths. Also when the Earth is in this Position, 'tis plain that the Terminator of Light and Darkness FL, will go beyond the North Pole B to L, 23½ Degrees distant from B; and consequently the South Pole A must be as far, from the Terminator LF in the darkned Hemisphere. Thro' the points L and F, draw the Circles LK, FG parallel to the Equator, and these Circles are called *Polar Circles*, that towards the North is called the *Artick Circle*, and that towards the South is called the *Antartick Circle*. Now since the Earth moves round upon its Axis AB, 'tis evident that every point within the artick polar Circle KL, will, at that time, have a continued Day; and on the contrary, every point within the antartick polar Circle FG, will have a continued Night.

Again, the Earth moving forwards thro' the Signs ♒ ♓ to ♈, the Sun will appear to move thro' the Signs ♋, ♌, ♍, and by Degrees to return again to the Equator; and when the Earth has come to the point ♈ of it's Orbit, the Sun will appear to be at ♎. Now the common Intersection of the Eclipticks and Equator still remaining parallel to the Line ♎ S ♈, 'tis plain

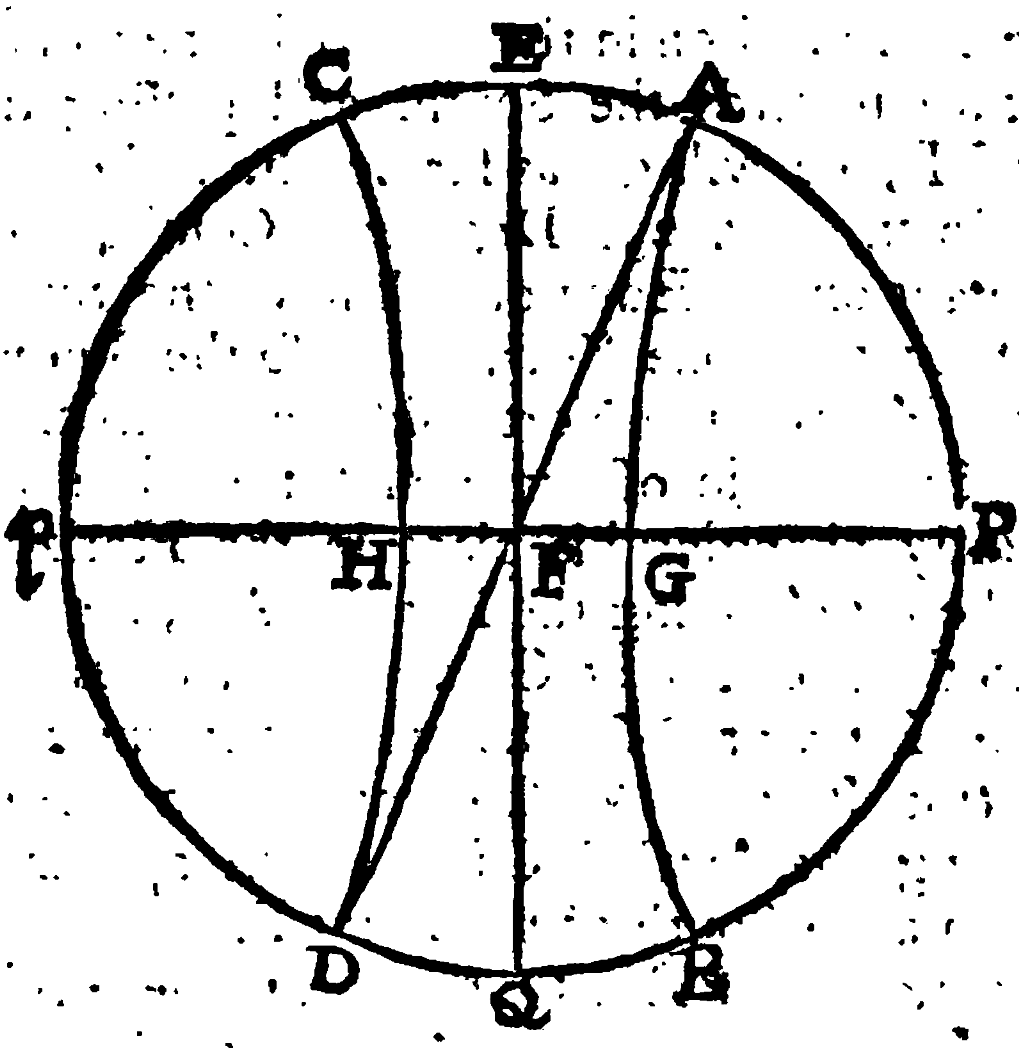
plain that when the Earth has come to ♈, the Line S ♈, joining the Centers of the Earth and Sun, will lie in the plain of the Equator; and consequently the Sun will appear in the celestial Equator, and there will be an Equality of Night and Day, the same way as when the Earth was in ♎; and in this situation, the Terminator of Light and Darkness will again pass thro' the two Poles.

The Earth moving forwards thro' the Signs ♈ ♉ ♊, the Sun will appear to move thro' the opposite Signs ♎ ♏ ♐, gradually declining from the Equator, towards the South Pole, and when the Earth comes to ♋, the Sun appears to be in ♑. Now since Axis of the Earth A B, does not change it's Inclination to the Ecliptick, the Earth will have the like Aspect and Position with respect to the Sun, as it had when in the point ♑ of its Orbit; but with this Difference, that he is now as far on the South Side of the Equator, as (when the Earth was in ♑) he was on the North Side, *i.e.* 23½ Degrees, and is perpendicular to the point N; the parallel N M is called the *Tropick* of *Capricorn*, and the Circle in Heavens concentric to this which he appears to describe at this time, is called the *Celestial Tropick* of *Capricorn*; because at this time the Sun appears to be in the Sign ♑; also, all within the North polar Circle K L, which was enlightned when the Earth was at ♑, is now in Darkness, and all within the South polar Circle, is now enlightned.

42. We shall now consider more particularly the Appearances that happen to the different Places upon the Earth, arising from it's annual Motion about the Sun, in conjunction with the Rotation about it's Axis. In order to which we must consider, that the Inhabitants of this Earth, with respect to their situation upon it, are divided into three Kinds, *viz.* *First*, Such as live upon the Equator. *Secondly*, Such as live between the Poles and Equator.

Thirdly,

Thirdly, Such as live upon either Pole. As for those that live upon the Equator; let E *p* Q P be the Projection of the Earth upon the plain of some Meridian, P the North, and *p* the South Pole, EQ the Equator, and E some place upon it; also D A the Ecliptick, C D the Tropick of Capricorn, and AB the Tropick of Cancer. Then 'tis plain that an Inhabitant upon the Equator, suppose at E, will have the two Poles P and *p* in his Horizon, which therefore must be a Meridian. And since all Meridians bisect the Equator and it's Parallels at right Angles, and all the Heavenly Bodies describing Parallels in their apparent diurnal Motion; 'tis



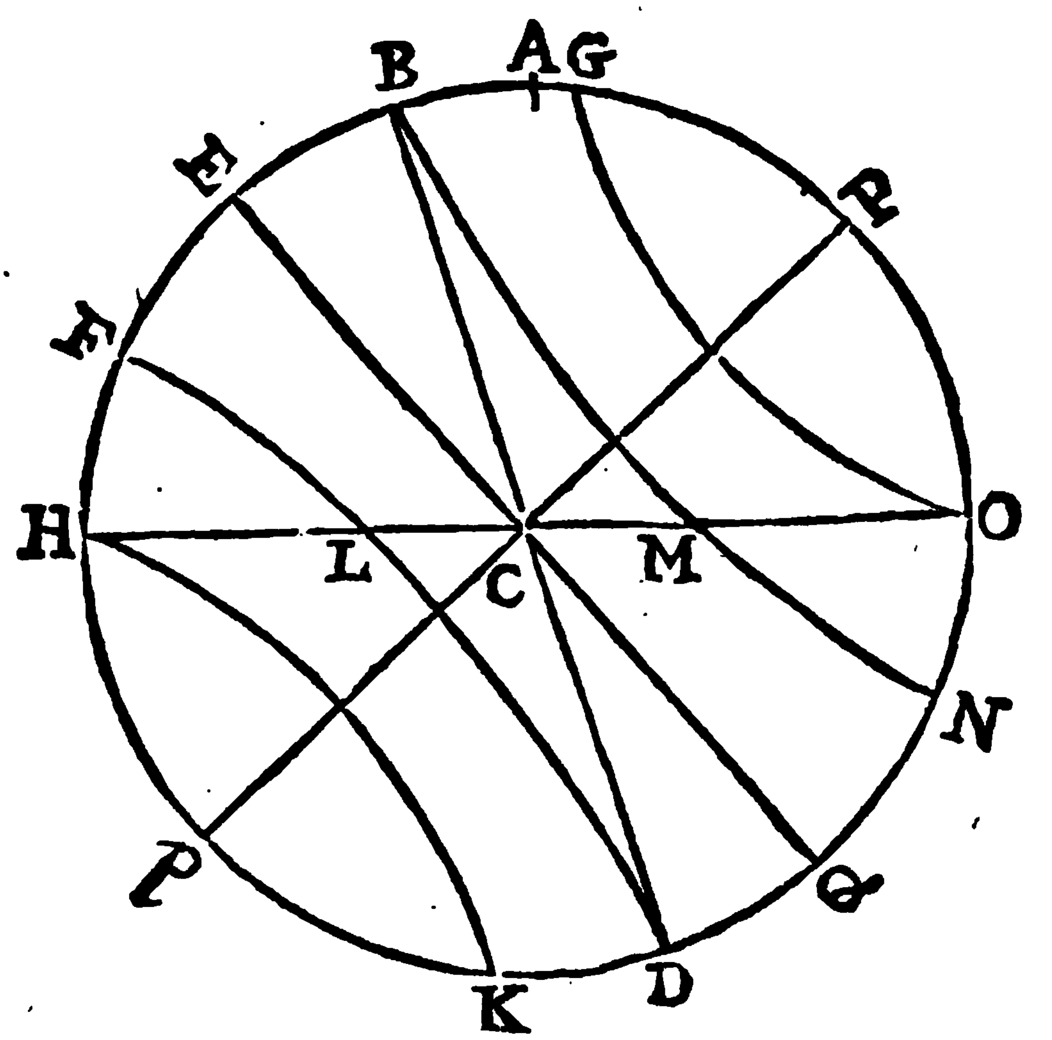
evident that in one intire Revolution of the Earth about it's Axis, all the Heavenly Bodies must come in view, and they must rise and set perpendicular to the Horizon, and be as long above it, as below, *i. e.* twelve Hours each. Now the Sun always describing some Parallel, or the Equator itself, in his diurnal Motion; it follows, that to an Inhabitant

upon the Equator there must be a constant equality of Night and Day, *viz.* twelve Hours each; and when the Sun in his annual Motion comes to be perpendicular to the Point F, he will then describe the Equator in his diurnal Motion; and consequently when he comes upon the Meridian of any place, E, on the Equator, he will be in the Zenith of it; and moving on in the Ecliptick till he be perpendicular to the Point A, (when he is at his greatest declination from the Equator towards the North Pole P, *viz.* 23½ Degrees) he will then describe the Tropick of Cancer AB, and when he comes on the Meridian of E, he will be remov'd from the Zenith towards the North 23½ Degrees; and moving still on in the Ecliptick, he will appear to return towards the South, and passing the Zenith of E, he will go as far South, as he was before North, *viz.* 23½ Degrees. Consequently an Inhabitant on the Equator will have the Sun in his Zenith twice in one Year, and also the Sun will be half the Year on the North Side, and half the Year on the South Side of him; and therefore will be constantly changing his place in the Horizon, for when he is describing the Parallel AB, he will appear in the Horizon at G, and when he is describing the Equator EQ, he will be in the Horizon at F (the East or West Points); also when he is describing the Parallel CD he will appear in the Horizon at H South of the Point F.

Again, Let PE*p*Q represent the Projection of the Earth on the Plain of some Meridian, P the North, and *p* the South Pole, EQ the Equator, and A some place upon that Meridian, lying between the Equator and North Pole, whose Horizion is HO; also BD the Ecliptick, BN the Tropick of Cancer, and FD the Tropick of Capricorn; thro' the points H and O, draw the parallels OG, HK. Then 'tis plain, that to an Inhabitant

at

at A, the North Pole P will be elevated above, and the South Pole *p* depreſs'd as much below the Horizon; and the Horizon will cut the Equator and it's parallels obliquely. Now ſince the Horizon and Equator are both great Circles, they muſt biſect one another (by *Art.* 4. *Cor.* 2.); therefore half the Equator will be above, and half below the Horizon; conſequently when the Sun is perpendicular to the Point C, that is, when he appears to be in the Equator, there will be an Equality of Night and Day. And ſince the Horizon cuts the parallels obliquely, it muſt therefore cut them unequally, and 'tis plain from the Scheme, that of thoſe parallels which lie between the Equator and neareſt Pole, the greater Part is above the Horizon, and the leſſer below; and thoſe that lie on the other Side of the Equator, has the leſſer



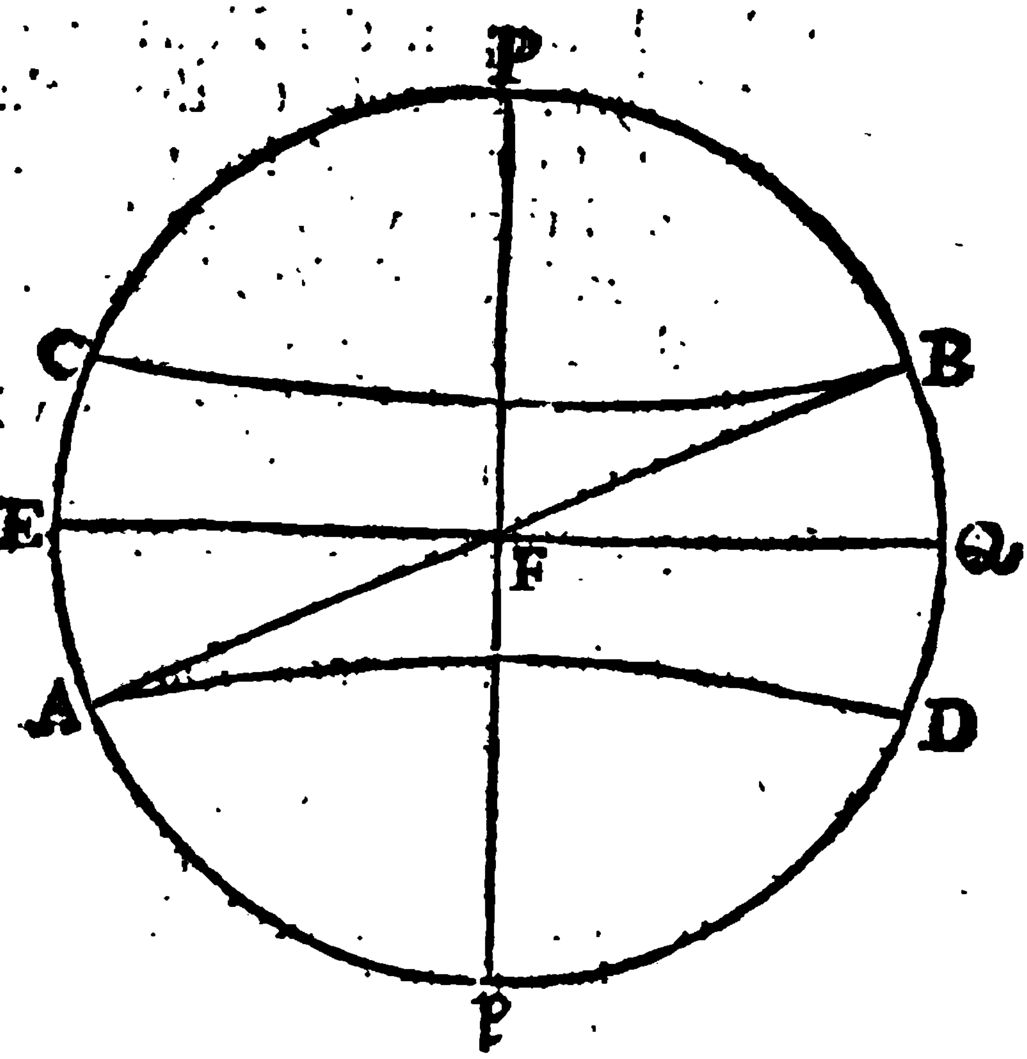
Part above and the greater below the Horizon; and the nearer the Parallels are to the Poles, the more unequally are they cut by the Horizon.

 Conſe-

Consequently while the Sun is upon the North Side of the Equator, and by his diurnal Motion describing Parallels, lying between the Equator and North Pole; 'tis plain he will be longer above than below the Horizon of the Place A; and when he comes to his greatest Declination North, and then describes the Tropick of Cancer, 'tis plain the Days must then be at the longest to the place A; also the Sun returning towards the Equator, he will describe Parallels, whose parts above the Horizon, grow still nearer to an Equality with those below, and so the Days will still decrease and come nearer to an Equality with the Nights, till he come to the Equator, when the Day and Night are equal; and proceeding from the Equator towards the South Pole, he will then describe Parallels lying between the Equator and South Pole, whose least Part is above, and greatest Part below the Horizon, and consequently the Days will still grow less than the Nights till he comes to the Tropick of Capricorn, when the Day is least and the Night greatest; and then returning to the Equator, the Days will increase and the Nights decrease. When the Sun is upon the Equator, 'tis plain, from the Scheme, that his place upon the Horizon will be C, that is, he will rise on the East Point and set on the West Point of the Horizon, and when he is in the Tropick of Cancer B N, his place upon the Horizon will be M, which is North of the Point C, also when he is in the Tropick of Capricorn F D, his place upon the Horizon will be L, which is South of the Point C; from which 'tis plain, that the Sun will be always changing his place upon the Horizon. Again, since the Horizon of A cuts the Equator and it's Parallels obliquely, and the Heavenly Bodies by their apparent diurnal Motion, describing Parallels, 'tis plain they must rise and set obliquely; also all of them within the Parallel

GO can never riſe or ſet, but muſt be conſtantly in View; for which reaſon this Parallel GO is called *The Circle of conſtant Apparition*; and all within the Parallel HK can never come in View, but be conſtantly below the Horizon, and therefore the Parallel HK is called *The Circle of Perpetual Occultation.*

Laſtly, Let PE *p* Q repreſent the projection of the Earth upon ſome Meridian, P the North and *p* the South Pole, EQ the Equator, AB the Ecliptick, BC the Tropick of Cancer, and AD the Tropick of Capricorn; then 'tis plain that the Equator is the Horizon of both Poles, and conſequently the Northern Hemiſphere muſt always be in view, and the Southern always hid to an Inhabitant at P; alſo the Heavenly Bodies will appear to move in Circles parallel to the Horizon, and the



fix'd Stars will ever deſcribe the ſame Parallels, and always have the ſame Height above the Horizon. When the Sun by his annual Motion

comes

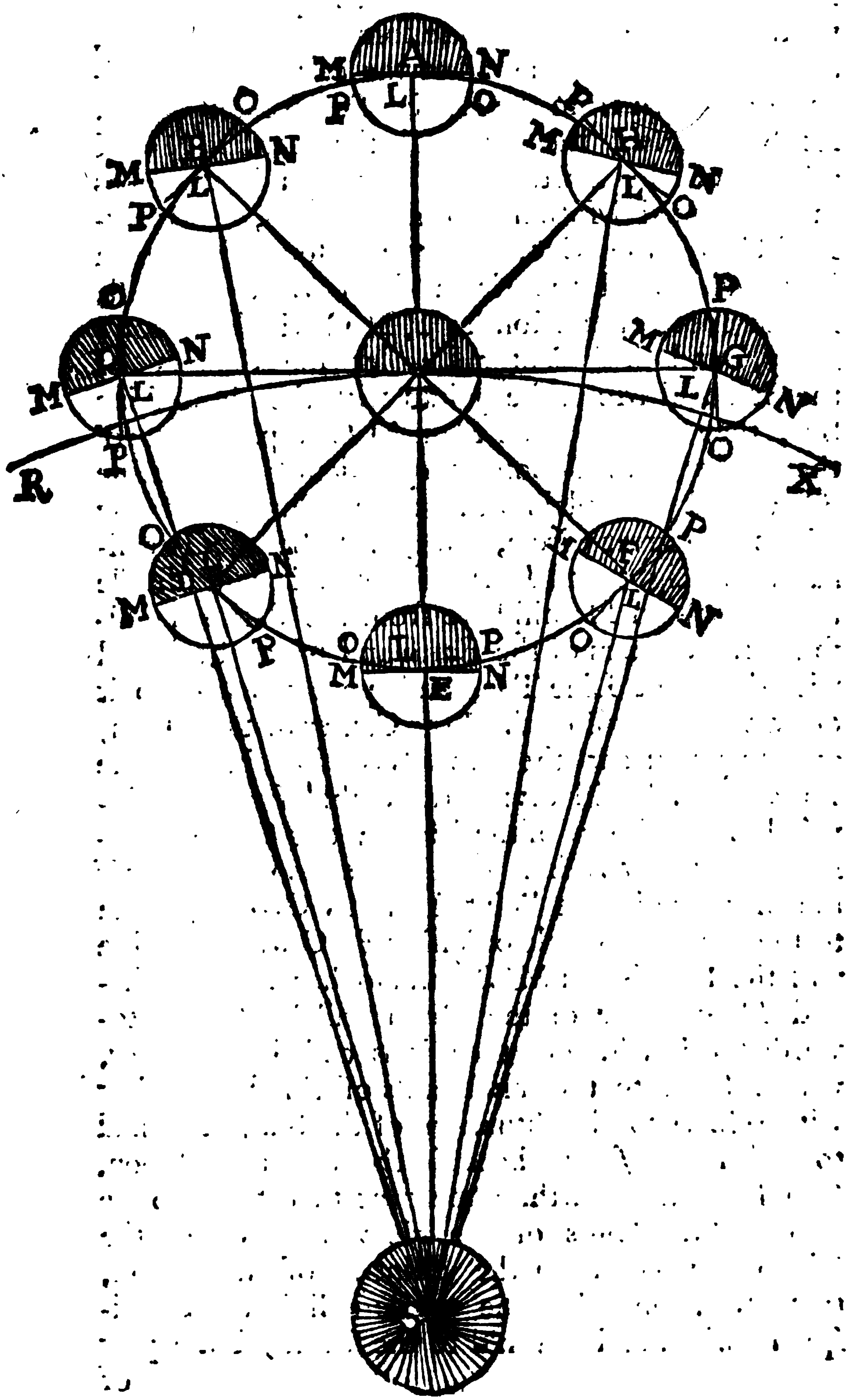
comes to be perpendicular to the Point F, and then describes the Equator, 'tis plain he will be in the Horizon of both Poles, and by his diurnal Motion will appear to move quite round it; and since half the Ecliptick FB is above, and the other half FA below the Horizon of P, 'tis plain all the time the Sun is in describing that half of the Ecliptick on the North Side of the Equator, he will be above the Horizon of P, and all the time he is in describing the other half on the South Side of the Equator, he will be below the Horizon of P; from which 'tis plain, that an Inhabitant of either Pole will have half a Year continued Day, and as long Night. And since the Sun's greatest Distance from the Equator South or North is 23½ Degrees, 'tis plain his greatest Altitude, or Depression, above or below the Horizon of either Pole must be 23½ Degrees.

43. Those that live upon the Equator are said to have a *Right Sphere*, because to them the Heavenly Bodies appear to rise and set perpendicular to the Horizon; and those who live between the Equator and either Pole are said to have an *Oblique Sphere*, because the Heavenly Bodies appear to rise and set obliquely; and *Lastly*, those who live on either Pole are said to have a *Parallel Sphere*, because the Heavenly Bodies appear to move parallel to the Horizon.

44. The *Moon* being an opack spherical Body, it receives it's Light from the Sun and reflects that upon the Earth, and that half of it which is opposite to the Sun is enlightned while the other half, which is averse from it, is involv'd in Darkness; but the half which is visible to us, is that which is opposite to the Earth; and therefore according to the various Situations of the Moon, with respect to the Earth and Sun, it will have different Illuminations; for sometimes a greater and sometimes a lesser

lesser part of the enlightned Hemisphere is turn'd to the Earth; and likewise sometimes the whole, and sometimes none at all of the enlightned Hemisphere is seen from the Earth. To explain which, let S represent the Sun, T the Earth, R T X a Part of the Earth's Orbit, which it describes in it's annual Motion about the Sun, A B C D E F G H, the Orbit of the Moon, in which it moves round the Earth from West to East, in the space of a Month; P N O M the Moon's Body, and it's Center L; let the Centers of the Sun and Moon be join'd with the right Line S L, then suppose the Plain M L N passing thro' the Center of the Moon, perpendicular to the Line S L; and this plain will cut the Surface of the Moon in a great Circle, which will be the Terminator of Light and Darkness, *viz.* it will divide the enlightned Hemisphere from the darkned; also let the Centers of the Earth and Moon be join'd with the right Line T L, and perpendicular to it draw a Plain passing thro' the Center of the Moon, and this will cut the Moon's Surface in a Circle P L O, which will divide the visible from the invisible Hemisphere of the Moon; this Circle is called *the Circle of Vision.* And hence 'tis plain, that if the Moon be in the Point A of it's Orbit opposite to the Sun, the Circle of Vision P L O will co-incide with the Terminator M L N, and so the whole enlightned Hemisphere of the Moon will be turn'd towards the Earth, and then it is called *Full Moon*, with respect to the Inhabitants of this Earth, but with respect to the Situation of the Sun, it is said to be in *Opposition*; because the Sun and Moon, seen from the Earth, appear at that time to be in opposite Points of the Heavens. When the Moon has come to the Point B of it's Orbit, then 'tis plain, that the whole enlightned Hemisphere will not be turn'd to the Earth, but a part

of


M
N
O
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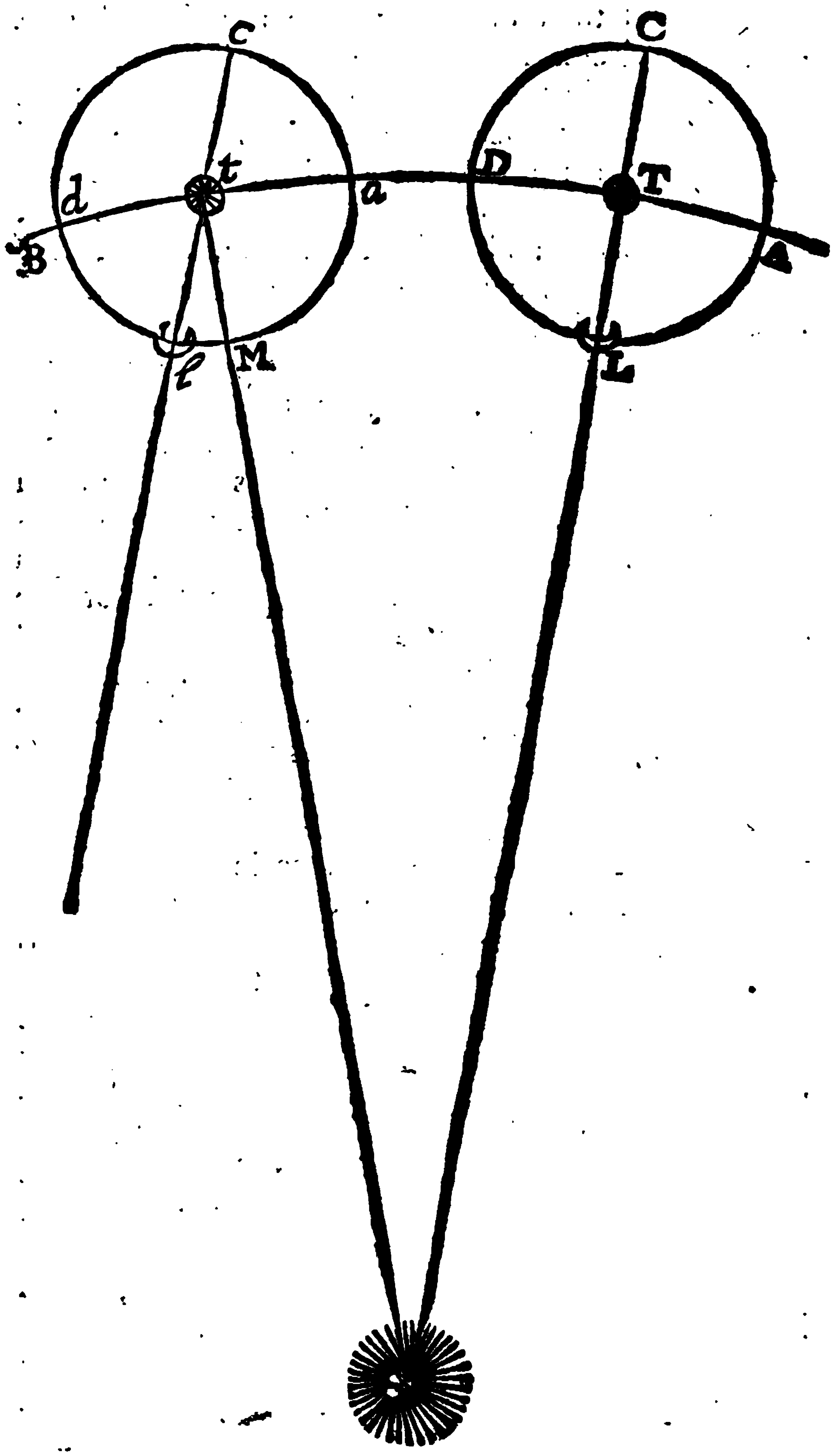
of it, as MP, will be without the visible Hemisphere, and therefore the visible illuminated Part cannot be circular, but will appear gibbous; when the Moon is in the Point C of her Orbit, and the Angle CTS a right Angle, then the Angle TCS will also be a right Angle (at least differing little from it) for because of the vast distance of the Sun, from the Earth and Moon, the Lines ST, SC may be taken as parallel; consequently the Circle of Vision will bisect the Terminator at right Angles, and so only one half of the enlightned Hemisphere will be in the Visible, and then the Moon appears to be halv'd, and is call'd *Half Moon*. In this Situation the Moon is only a Quadrant's distance from the Sun, and therefore it is said to be in one of it's *Quadratures*. The Moon proceeding to D, 'tis plain that in this Situation only a small part PN of the enlightned Hemisphere is turn'd to the Earth, and the greatest part NO of the visible Hemisphere is darkned; and consequently, because of the spherical Figure of the Moon, it will then appear horned, and it's Horns will be turn'd towards the West. When the Moon is arriv'd at E, 'tis plain the Circle of Vision will again co-incide with the Terminator, and the whole darkned Hemisphere will be turn'd to the Earth, and then it is said to be *New-Moon*; but with respect to it's Situation with the Sun it is said to be in *Conjunction*, because it appears to be in the same point of the Ecliptick with the Sun; and when it has mov'd a little forward to F, 'tis plain part of the enlightned Hemispher, *viz.* MO, will be in the visible, and so it will again appear horned, and having them turn'd towards the East; also when at G it will appear halv'd, and when at H gibbous; and *Lastly*, when it comes to A it will again appear full.

45. Tho' (as was said in *Art.* 29.) the Moon moves quite round it's Orbit in 27 Days, and

O 7 Hours,

7 Hours, nearly, call'd the *Periodic Month*; yet the



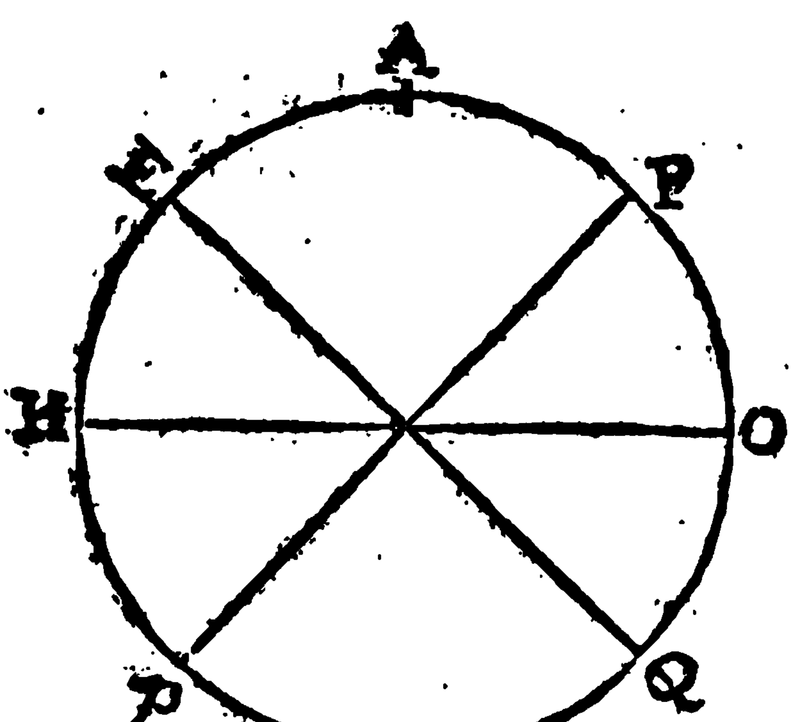
Time

Time it takes from one Conjunction with the Sun, to the next, is greater; being 29 Days, and about 12 Hours, which is call'd *the Synodic Mouth*; for let S be the Sun, T the Earth, AB a part of the Earth's Orbit about the Sun, and ALDC the Orbit of the Moon; then when the Earth is in T let the Moon be in L, in Conjunction with the Sun; and when the Moon is moving from L round it's Orbit LACD, 'tis plain that the Earth in the mean time will be moving on in it's Orbit about the Sun, and carrying the Moon's Orbit along with it. And when the Moon has mov'd quite round it's Orbit, the Earth will be carried from T to *t*, and the Moon's Orbit will be in the Situation, *l a c d*, and the point L will be in the Line *t l*, parallel to the former TL, and consequently the Moon will then be in *l*; but will not be in Conjunction with the Sun till it has mov'd a little further and describ'd the Arch *l*M, which is similar to the Arch *t*T, because the Angles *lt*M, *t*ST are equal (by *Art.* 36. *Sect.* 1.). And hence it is that tho' the Moon moves round it's Orbit in 27 Days, 7 Hours, yet from new Moon to new Moon it takes 29 Days, 12 Hours.

46. If the Moon's Orbit lay in the plain of the Ecliptick; 'tis plain in a Month's time the Moon would move round the same Circle in the Heavens, that the Sun appears to do in a Year, *viz.* the Ecliptick; but the Moon's Orbit does not lie in the same plain with the Ecliptick, but is inclin'd to it at an Angle of about five Degrees, and consequently must intersect it in a right Line passing thro' the Center of the Earth; and one half of the Orbit will be above the Ecliptick towards the North, and the other half below towards the South. The Line of Intersection is call'd *the Line of the Nodes*, the two Extremities of which are called *the Nodes*. The Node in which the Moon is when

ascending above the Ecliptick, towards the North, is called *the Ascending Node, or Dragon's Head*, for brevities sake marked thus ☊; and the opposite one, *viz.* that in which the Moon is when descending below the Ecliptick towards the South, is called *the Descending Node, or Dragon's Tail*, marked thus ☋. Hence 'tis plain, that the Moon cannot appear in the Ecliptick above twice in one Period, *viz.* when it is in the Nodes; and in other points of it's Orbit, it will be more or less distant from the Ecliptick, according as it is more or less removed from the nearest Node; these two opposite points in the Orbit, that lie in the middle between the Nodes, are called *the Limits*; and when the Moon is in either of these, she is then at her greatest Distance from the Ecliptick.

47. The Height of the nearest Pole above the Horizon of any place, is equal to the Latitude of that place. For let A be any place upon the Earth, A H O it's Meridian, H O the Horizon, E Q the Equator, P and *p* the two Poles; then 'tis plain A E will be the Latitude of the place, and



P O the Height of the nearest Pole above the Horizon. Now since the Arches P E, and A O are equal,

equal, being each a Quadrant, from both take the common Arch AP, and there will remain AE equal to PO; that is, the Height of the Pole above the Horizon is equal to the Latitude. Also since the Arches AH, and EP are equal, being both Quadrants, from both take the common Arch AE, and there will remain EH equal AP; that is, the Height of the Equator above the Horizon of any place, is equal to the Compliment of the Latitude of that place.

48. Great Circles passing thro' the poles of the Ecliptick and cuting it at right Angles, are called Secondaries of the Ecliptick.

49. *The Latitude* of any Heavenly Body, is an Arch of the Secondary passing thro' the Center of the Object, intercepted between it and the Ecliptick; and it is either North or South, according as the Object is on the North or South Side of the Ecliptick.

50. *The Longitude* of any Celestial Body, is an Arch of the Ecliptick intercepted between the Secondary passing thro', that Body, and the first point of Aries.

51. *The Declination* of any Heavenly Body is an Arch of a Meridian, passing over that Body, intercepted between the Center of it and the celestial Equator; and it is either North or South according as the Body is on the North or South Side of the Equator.

52. Since the Sun by his annual Motion, is always either approaching nearer to, or going further from, the Equator; 'tis plain he must be continually changing his Declination. In the third Table at the End of this Book, you have his Declination for every Day of the Year; in which you may observe that in the Top Columns stands the Year, Month, and kinds of the Declination, *viz*, whether it be South or North; and in the left Hand

Column

Column stands the Day of the Month; the other Columns contains the Declinations answerable to these; consequently to find the Sun's Declination for any Day, supppose the twentieth of *April*, 1731. I look at the Top for the Year 1731, and the Month *April*, and in the side Column for 20, then in the Column below *April*, and on the same Line with 20, I find 14°, 59′ for his Declination North; and the same Way his Declination may be found for any other Day. But you must observe that this Table is calculated only for the Meridian of *London*, and the Noon there; that is, it shews the Declination of the Sun when upon the Meridian of *London*; and consequently to find the Sun's Declination for any other Time of the Day, we must consider whether the given Time be before or after Noon; if it be before, then say as 24 Hours is to the Difference between the Declination of the Sun, the Noon of the preceeding Day, and his Declination the Noon of the present Day; so is the Time from Noon last Day, to a fourth Propotional; which, if the Declination be increasing, must be added to, but if decreasing substracted from, the Sun's Declination the Noon of the proceeding Day; and the Sum, or Remainder, is the Declination for the present Time.

Example. Suppose it were requir'd to find the Sun's Declination, on the fourth Day of *April* 1731, at 8 Hours, 25 Minutes in the Morning. To do this, I first look in the Tables, for the Sun's Declination the fourth Day of *April* 1731, and find it to be 9°, 39′; then I look for it the third Day, and find it to be 9°, 17′, the difference of these is 22′; then I say as 24 Hours, is to 22′; so is 20 Hours 25 Minutes, the time elapsed since last Noon, to 18′; which added to 9°, 17′ (because the Declination is increasing) gives 9°, 35′, for the Sun's present Declination. Again, if the Time proposed

proposed be after Noon; then to find the Declination for that Time, we must look in the Tables, for the Sun's Declination the Noon of the present Day; and for the same, the Noon of the following Day, and take the Difference of these Declinations; then say, as 24 Hours is to the Difference of the Declinations, so is the Time elapsed since Noon, to a fourth Proportional; which added to, or substracted from, the Sun's Declination the present Day at Noon (according as the Declination is increacsing or decreasing) gives the Sun's Declination at the Time proposed.

Example. Suppose it were required to find the Sun's Declination on the twelfth Day of *July* 1731, at 4 Hours, 23 Minutes after Noon. To do this we must first look in the Tables, for the Sun's Declination the twelfth Day of *July* 1731; and will find it to be 20°, 13′, then for his Declination the following Day, which is 20°, 01′, and the Difference between these Two is 12′; then say as 24 Hours, is to 12′, so is 4 Hours, 23 Minutes, the Time elapsed since Noon, to 2′, which (because the Sun's Declination is decreasing) substracted from 20°, 13′ the Declination of the Sun at Noon of the present Day, leaves 20°, 11′ the Sun's Declination for the Time proposed.

And since the Table of the Sun's Declination at the End of this Book is fitted to the Meridian of *London*, 'tis plain it cannot serve for the Meridian of any other place, lying on the East or West Side of the Meridian of *London*; for while the Sun by his apparent diurnal Motion is passing from one Meridian to another, he is at the same Time still moving on in the Ecliptick, and consequently altering his Declination. Now to find the Declination of the Sun when he is on the Meridian of any place, lying on the East or West Side of *London*, we must take the Difference of Longitude between *London* and the given

given Place (or if the Meridian of *London* be supposed the first Meridian, we must take the Longitude of the Place) and convert this into difference of Time, which will show the Time, before or after Noon at *London*, the Sun is upon the Meridian of the Place proposed; *viz.* if the Place lie on the East Side of *London*, the Time will be before Noon; but if on the West it will be after-Noon; then finding, according to the preceeding Examples, the Sun's Declination at the Time proposed, the same will be his Declination when on the Meridian of the proposed Place.

This may be done another Way, *viz.* by the help of the Table of the Variation of the Sun's Declination to every 15 Degrees of Longitude from the Meridian of *London*, annexed to the Table of Declination; the upper Column of which contains the Degrees, and the left hand side Column contains the Minutes of the Sun's daily Variation; and the other Columns contain the Minutes answering to the Degrees and Minutes in the Top and Side Columns. Now to find the Sun's Declination any Day, when he is on the Meridian of any place, lying on the East or West Side of *London*, by this Table; we must first find the Sun's Declination for the present and for the following Day; and the Difference between these two will give us the daily Variation at that time; then look in the Table of Variation, &c. at the Top, for the Difference of Longitude between *London* and the proposed place, and in the side Column for the Minutes of Variation; then below these Degrees in the Top and on the same Line, with the Variation in the side Column we will find the Variation required; which, if the proposed place be West of *London*, and the Declination increasing, must be added to the Declination for the present Day, and the Sum is the Declination required; but if the Declination

be

be decreasing, then the Variation subtracted from the Declination gives that required; again, if the place lie on the East side of *London*, and the Declination encreasing, then the Variation subtracted from the Declination for that Day, leaves the Declination ~~required; but if the Declination~~ be decreasing, then the Variation added to the Declination gives that required.

Example. Let it be required to find the Sun's Declination when he is on the Meridian of St. *Lucia* (whose Longitude from *London* is 60°, 15′ West) on the sixth Day of *April* 1731. To do this, I first look in the Tables for the Declination of the Sun the sixth Day of *April* 1731, and find it to be 19°, 15′, then for the same the following Day, and I find it to be 19°, 29′, the difference of which is 14 Minutes, the Sun's daily Variation at that time; then I look in the Top of the Table of Variation, &c. for 60 the difference of Longitude, and in the side Column for 14; and below 60, and in the same Line with 14, I find 2 Minutes, which (because the place is West of *London*, and the Declination encreasing) I add to 19°, 15′, and the sum is 19°, 17′, the Sun's Declination at St. *Lucia* the sixth Day of *April* 1731.

From this you may observe, that the Method of solving this Problem by the Table of Variation, &c. is not near so good as the former, for here we can only enter the Table with a Number of Degrees, which is either 15° or some Multiple of it below 195°, and all the odd Degrees and Minutes must be thrown away; but in the former Method we can use any number of Degrees and Minutes.

53. And since the fix'd Stars always keep the same places in the Heavens (at least in a few Years their Variation is insensible), 'tis plain their Declination must still be the same. At the End

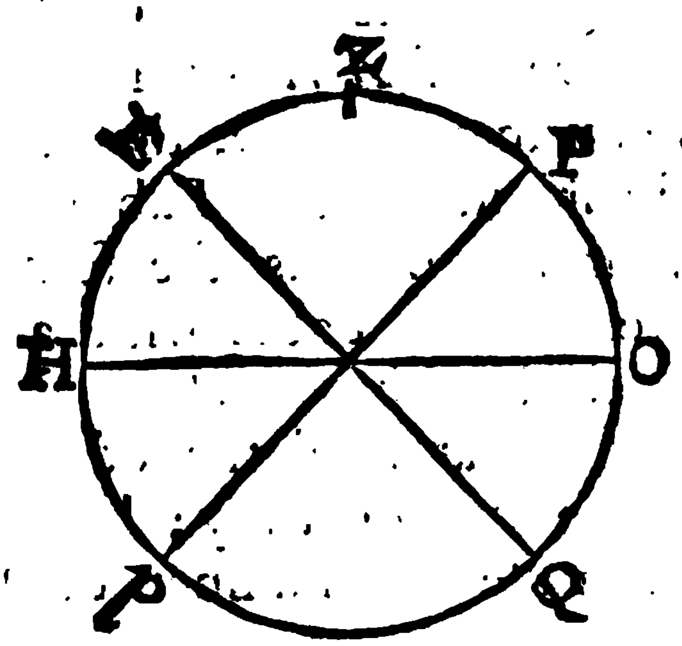
of the Table of the Sun's Declination, there is a Table of the Declinations of the most principal fix'd Stars.

SECT. IV.

TO *find the Latitudes of Places by the Meridian, Altitude, and Declination, of any Celestial Object.*

This *Problem* admits of several *Cases*, according as the observed Object is situate with respect to the Equator, and place of Observation; which are as follows.

Case 1. When the Sun or Star observed has no Declination, or is upon the Equator, then the Zenith distance of the Object is equal to the Latitude of the place, which is North Latitude of the Sun or Star come to the Meridian, on the South

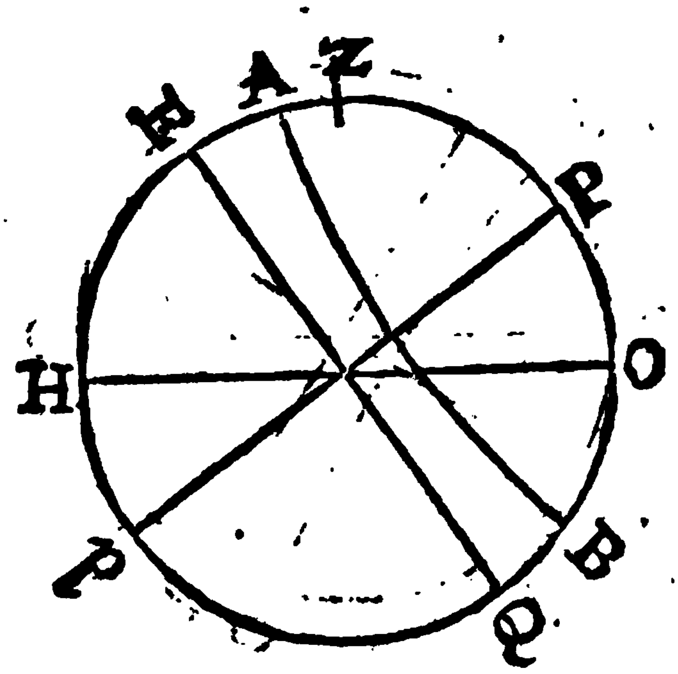


side of the Zenith; but South if on the North side. For in the annexed Scheme, let Z represent the place of Observation, PQpE it's Meridian, EQ the

the Equator, HO the Horizon, P the North and p the South pole; then 'tis plain, since the observed Object is supposed to have no Declination, that EQ will represent the path of it's diurnal Motion, and when it comes upon the Meridian, ZE will be it's Zenith distance, which is manifestly equal to the Latitude of the place Z. And when the Object at E is South of Z, 'tis plain the place Z must be North of E, and consequently the Latitude will be North.

Case 2. If the Sun or Star, when on the Meridian, is in the Zenith; then the Declination of the Object is the same with the Latitude of the place. For it is evident that in this Case they are equally distant from the Equator, and on the same side of it; consequently if the Declination be North, the Latitude will also be North, and if South, South.

Case 3. If the Sun or Star be between the Equator and place of Observation, then the Latitude of the place is equal to the sum of the Zenith distance and Declination of the Object; and it is of the same name with the Declination, *viz.* if the Declination be North, the Latitude is also



North, & *e contra.* For in the adjacent Scheme, let AB represent the Parallel described by the

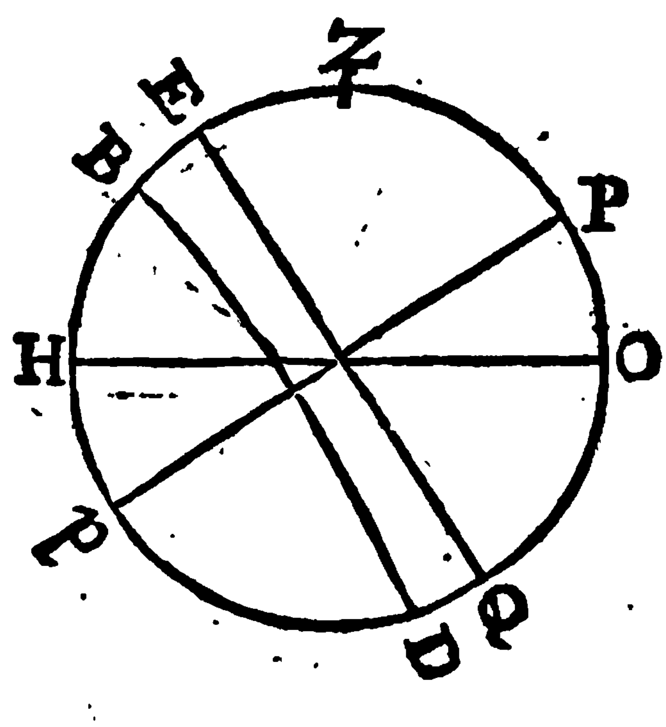
 observed

observed Object in it's diurnal Motion, and A it's place upon the Meridian, situate between Z, the place of Observation, and E Q the Equator; then 'tis plain that Z E the Latitude of the place Z, is equal to the sum of E A the Declination, and A Z the Zenith distance, and if the Declination be North, the Latitude will also be North, *&* *e contra*; since in this Case the Object and place of Observation lie both on the same side of the Equator.

Example. Suppose on the twelfth Day of *April* 1732, the Sun, when on the Meridian, has 52°, 12′ of Altitude, and consequently 37°, 48′ Zenith distance, required the Latitude of the place of Observation.

the Sun's Declination that Day is -	12°, 40′	N.
his Zenith distance - - - - -	37 , 48	
the sum is the Latitude, *viz.* -	50 , 28	N.

Case 4. If the Sun or Star be on the contrary side of the Equator, with the place of Observa-



tion, and consequently both Declination and Zenith distance be of the same Name, *viz.* either both North or both South; then the Latitude is found by

by taking the Declination from the Zenith distance, and it is of a contrary name with the Declination. For in the adjacent Figure let B D represent the Parallel described by the observed Object in it's diurnal Motion, on the other side of the Equator E Q with the place Z, and B will be it's place when upon the Meridian; then 'tis plain, that if from Z B, the Zenith distance, be taken B E the Declination, there will remain Z E, the Latitude of the place of Observation Z, and the Latitude will be of a contrary name with the Declination; since in this Case, the Object and Place are on contrary sides of the Equator.

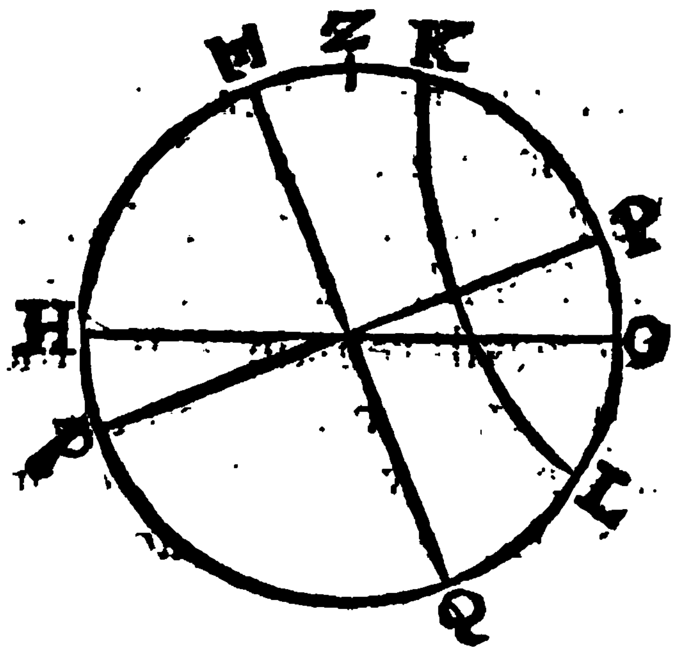
Example. Being at Sea the twelfth Day of *January* 1732, I found the Meridian Altitude of the Sun to be 43°, 15′; consequently his Zenith distance 46°, 45′, and he was South of me: Required the Latitude of the place of Observation, and which way it is.

From the meridional Zenith distance -	46°,	45′,	S.
take the Sun's Declination - - -	19,	35,	S.
there remains the Latit. of the place	27,	10,	N.

When the Zenith Distance and Declination are equal, and both of the same Name, then the Latitude vanishes, and consequently the place is situated on the Equator.

Case 5. If the Sun or Star be between the place of Observation and the nearest Pole, and consequently both Declination and Zenith distance be of the same name; then from the Declination subtract the Zenith distance, and the Remainder is the Latitude of the place of Observation, and it is of the same name with the Declination. For in the annex'd Scheme, let K L represent the Parallel described by the observed Object in it's diurnal Motion, and K will be it's place when upon the Meridian; then 'tis plain, that if from KE the Declination, be taken ZK the meridional Zenith distance, there will remain

remain ZE the Latitude of the place, which will be of the same name with the Declination, since the



Object and place of Observation are in this Case upon the same side of the Equator.

Example. 1. Suppose on the twenty third Day of *June* 1733, I observed the Meridian Altitude of the Sun to be 82°, 4′; consequently his Zenith distance 7°, 56′: Required the Latitude of the place of Observation, and which way it is.

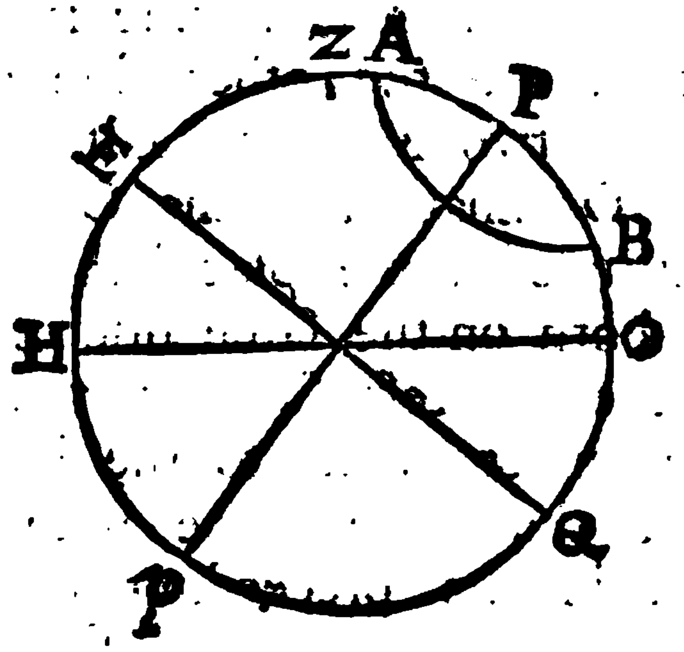
The Sun's Declination that Day is -	22°, 55′	N.
his Zenith distance is - -	7 , 56	N.
the Difference is the Latitude, *viz.* -	14, 59	N.

Example. 2. Being at Sea, I observed the Meridian Altitude of the middlemost Star in the Tail of the great Bear, to be 56°, 44′ North; consequently it's Zenith distance 33°, 16′, and it's Declination being 56°, 22′ North: Required the Latitude of the place of Observation, and which way it is.

From the Declination - -	56°, 22	N.
take the Zenith distance - -	33 , 16	N.
there remains the Latitude - -	23 , 06	N.

Case 6.

Case 6. If the Sun or Star be between the Horizon and the elevated Pole, then to the Altitude add the Complement of the Declination, and the Sum will be the Latitude of the place of Observation, and of the same name with the Declination. For let AB be the Parallel described by the Object in it's diurnal Motion, B it's place on the Meridian, when between the Horizon and elevated Pole; then 'tis plain, that if to BO the Altitude, be added BP the Complement of the Declination of the Object, the sum PO will be equal to the Height of the Pole above the Horizon, which (by *Art.* 47. *Sect.* 3.) is equal to the Latitude of the place of Observation Z, and it will be of the same name with the Declination, since both the Place and the Object are on the same side of the Equator.



Example. Being at Sea, I observed the bright Star of the *Harp* on the Meridian, between the Horizon and elevated Pole, it's Altitude being 8°, 33', and Declination 38°, 33' North: Required the Latitude of the place of Observation.

To the Compliment of the Declinat.	51°, 27 N.
add the Altitude - - - - - -	8 , 33 N.
the sum is the Latitude - - -	60 , 00 N.

Case 7.

Case 7. When the observed Object does not sett, and consequently the Compliment of it's Declination less than the Latitude of the place; then 'tis plain, the Object will be twice upon the Meridian in 24 Hours, *viz.* at it's least and greatest Altitude; when the Altitude is least the Object is then between the Horizon and elevated Pole, and by that Altitude and Declination of the Object, the Latitude of the place may be found (as in the last Case); but when the Altitude is greatest, the Object is then on the other side of the Pole. Now with these two Meridian Altitudes, without knowing the Declination of the Object, we can find the Latitude of the place, thus; if the two Altitudes be both on the same side of the Zenith, then from the greatest subtract the least, and half the Remainder added to the least gives the Latitude, of the same name with the Zenith distance; for in the preceeding Scheme, where A B represented the Parallel of Declination, described by the Object in it's diurnal Motion, B O it's least, and A O it's greatest Meridian Altitude, 'tis plain, if from A O be taken B O, the difference will be A B, the half of which P B added to B O, gives P O the Height of the Pole above the Horizon, equal to the Latitude of the place.

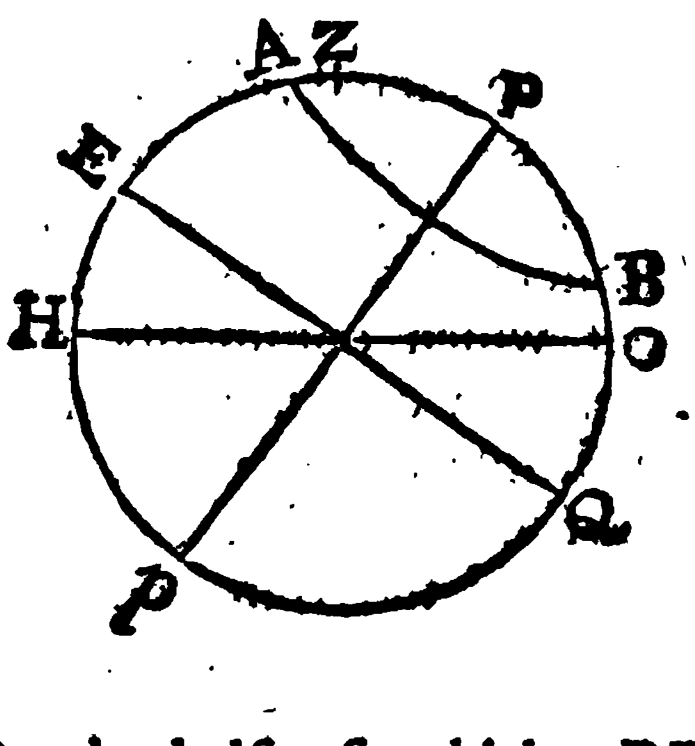
Example. Being at Sea, I observed the Northermost of the two preceeding Stars in the Square of the *Great Bear*, which did not sett, and found the least Altitude to be 23°, 12′, and the greatest 72°, 46′, both North of my Zenith: Required the Latitude of the place of Observation.

From the greatest Altitude - - -	72°, 46′ N.
take the least - - - -	23 , 12
the Remainder is - - - -	49 , 34
the half of which is - - - -	24 , 47
to which adding the least Altitude	23 , 12
the sum will be - - - -	47 , 59

which

which is equal to the Latitude of the place, and it is North, because the Zenith distance is on the North side.

But if the greatest and least Meridian Altitudes of the Object be upon different sides of the Zenith, *viz.* the one upon the North and the other upon the South side; then from the Supplement of the greatest Altitude subtract the least, and half the Remainder added to the least Altitude, will give the Latitude of the place of Observation, which will be of the same name with the least Altitude, *viz.* North; if the least Altitude be North of the place, *& e contra.* For in the annex'd Figure, let B A represent the Parallel described by the Object in it's diurnal Motion, B and A the places of the Object when upon the Meridian, on contrary sides of the Zenith Z; B O it's least Altitude, and H A it's, greatest Altitude, the Supplement whereof is A O. Now 'tis plain, that if from A O we take O B, the Remainder



will be A B, the half of which, P B, added to B O makes P O the Height of the Pole above the Horizon, or Latitude of the place Z; which will be North if the least Altitude B O be on the North side of the place, because in this Case the North pole will be elevated.

Example. Being at Sea, I obſerved the Sun when he did not ſett, and found his leaſt Meridian Altitude to be 3°, 29′ on the North ſide of the Zenith, and his greateſt Meridian Altitude was 43°, 29′ on the South ſide: Required the Latitude of the place of Obſervation.

From the Supplement of the Sun's greateſt Meridian Altitude - -	136°, 31′
take his leaſt Altitude - - - - -	3 , 29
and there remains - - - - - -	133 , 02
the half of which is - - - - -	66 , 31
to which adding the leaſt Altitude -	3 , 29
the ſum is - - - - - - - - - -	70 , 00 N.

the Latitude of the place of Obſervation.

SECT. V.

Of the Elements of Chronology.

1. TIME conſidered abſtractly, without any relation to external Objects, flows always equally and uniformly, and it is called Abſolute, True, and Mathematical Time, or, ſimply, *Duration.* But that which commonly goes under the name of Time, is a certain part of Duration meaſured by the ſimple and uniform Motion of ſome Body, ſuch as the Motion of the Celeſtial Bodies; and particularly of the Sun and Moon; this is called Relative, Apparent, or Vulgar Time.

2. Time is divided into Years, Months, Weeks, Days, Hours, Scruples or Minutes, &c.

3. A Day is of two Kinds, *viz. Natural* or *Artificial*; a *Natural Day* is that ſpace of Time that flows while the Sun moves from any Meridian, till he comes to the ſame again. An *Artificial Day* is

is that ſpace of Time that the Sun continues above the Horizon, and the Time he continues below it is called a *Night.*

4. An *Hour* is a certain determinate part of the Day, and is either *equal* or *unequal.* An *equal Hour* is the twenty fourth part of a natural Day; and an *unequal Hour* is the twelfth part of an artificial Day, which is alſo called a *diurnal Hour*, as the twelfth part of the Night is called a *nocturnal Hour*; theſe are likewiſe called *Temporary Hours*, becauſe at different ſeaſons of the Year they are of different Lengths; for a diurnal Hour in the Summer is longer, and a Nocturnal ſhorter; than in the Winter; but in the equinoctial Day, a diurnal Hour is equal to a nocturnal, and then they are called *equinoctial Hours.*

5. The *diurnal Hours* begin at the riſing and end at the ſetting of the Sun; and the *nocturnal Hours* begin at the ſetting and end at the riſing of the Sun. Theſe Hours were anciently in uſe among the *Jews* and *Romans*, and at preſent among the *Turks.* They were anciently called planetary Hours, becauſe in every Hour one of the ſeven Planets was ſuppos'd to preſide over the World; thus for Example, on *Sunday*, the firſt Hour from Sun-riſing was allotted to the *Sun*, the ſecond fell to *Venus*, the third to *Mercury*, and ſo on to the reſt in order, *viz.* to the *Moon*, *Saturn*, *Jupiter* and *Mars*; by which means, the firſt Hour from Sun-riſing, the next Day fell to the Moon; from which it was called *Monday*, and ſo on thro' the other Days of the Week, each Day getting it's name from the Planet that was ſuppoſed to preſide the firſt Hour of that Day.

6. The Day in different Nations begins at different Times. Thus the *Babylonians*, *Aſſyrians*, and ſeveral other eaſtern Nations began their Day at Sun-riſing; the Hour after that, they called the

first Hour, and so counted on till they came to the twenty fourth or last Hour, which was the Hour before Sun-rising. The *Jews* and *Grecians* began their Day at Sun-sett; as at this Time the *Italians*, *Sicilians*, *Bohemians*, *Polanders* and *Austrians* do; the Hour before the Sun-sett they call the last or twenty fourth Hour, and the Hour after the Sun is sett, they call the first Hour; and so count on to the twenty fourth, when the Sun-setts again.

7. The *Egyptians*, and *Romans*, anciently began their Day at Mid-night; which was followed by *Hipparchus*, *Copernicus*, and other *Astronomers*, in their Astronomical Observations, and is still retained in *Britain*, *France*, *Spain*, and most other places in *Europe*; but the *Arabs* and modern *Astronomers*, begin the Day at Noon, *viz.* when the Sun is upon the Meridian.

8. A *Week* is a Succession of seven natural Days, each of which has a particular Name allotted to it, *viz.* the first is called *Sunday*, the second *Monday*, and so on.

9. A *Month* is a certain System of Days, consisting of something more or less than thirty Days, and is of two kinds, *viz. Astronomical* or *Civil*; an *Astronomical* Month is that which is governed either by the motion of the *Sun*, or that of the *Moon*; and consequently is of two kinds, *viz. Solar* or *Lunar*. A *Solar Month* is that time which the Sun takes to run thro' a whole Sign, or the twelfth part of the *Ecliptick*; and a *Lunar Month* is that which is measured by the motion of the *Moon* round the Earth, and is of three kinds, *viz. Periodical*, *Synodical*, and that of *Illumination*; the *Periodical* and *Synodical Months* are defin'd in *Art.* 45. *Sect.* 3. and the *Month of Illumination* or *Apparition*, is that space of time contained between the Day that the *Moon* begins to appear after change, to the Day that she disappears; and this

consists

consists of twenty eight Days nearly. A *Civil* or *Political* Month, differs from the *Astronomical*, and consists of more or fewer Days according to the Institution of the Country in which they are used.

10. A *Year* is a certain system of Months, and is either *Astronomical* or *Civil*; the *Astronomical Year* is of two kinds, *viz.* *Solar*, or *Lunar*; and the *Solar Year*, is either *Sidereal* or *Tropical*. The *Sidereal Year* is that space of Time that the *Sun* takes to move from a fix'd Star till he return to the same again; and it consists of of 365 Days, 6 Hours, 9 Minutes, and 14 Seconds; the *Tropical Year* is that space of Time which flows while the *Sun* moves from any one of the *Cardinal Points*, till he returns to the same again; and it consists of 365 Days, 5 Hours, 48 Minutes, and 57 Seconds, and commonly gets the name of the *Solar Year*.

11. A *Lunar Year* consists of a certain number of Months, and is either *Common* or *Embolismic*. A *Common Lunar Year* consists of twelve *Synodic Lunations*, and an *Embolismic* contains thirteen.

12. *The Civil* or *Political Year* consists of a certain number of Days, more or fewer, according to the Laws and Customs of the Countries in which it is received.

13. Since the *Common Lunar Year* consists of twelve *Synodic Months*, or 354 Days nearly, and the *Solar* consists of 365 Days, (throwing away the odd Hours and Minutes) 'tis plain that the *Solar Year* will exceed the *Lunar* by about 11 Days; and consequently in the space of about thirty three Years the beginning of the *Lunar Year* will be carried thro' all the Seasons; and hence it is called the *Moveable Lunar Year*. This form of the Year is used at this Time by the *Turks* and *Arabians*; and because in three years Time, the *Solar* exceeds the *Lunar* by 33 Days; therefore to keep the

the *Lunar Months* in the ſame Seaſons and Times of the *Solar Year*, or near it, they added a whole Month to the *Lunar Year*, every third Year, and ſo made it conſiſt of thirteen Months; this Year they called the *Emboliſmic Year*, and the additional Month, the *Embolimean* or *Intercalary Month.* This form of the Lunar Year is called the fix'd *Lunar Year*; and it was uſed by the *Greeks* and *Romans* till *Julius Cæſar's* time.

14. The *Egyptians* made uſe of the *Solar Years*, and made each conſiſt of 365 Days, which wants of the *Tropical Year*, almoſt 6 Hours; and conſequently the *Egyptian* Year began always 6 Hours ſooner than the immediately preceeding *Tropical Year*; by which means in four times 365 or 1460 Years, (called the *Great Canicular Year* or *Sothiacal Period*) the beginning of the Year moved thro' all the Seaſons.

15. *Julius Cæſar*, in order to reduce the *Civil* or *Political Year*, nearly to an equality with the *Tropical*, and conſidering that the *Tropical Year* conſiſted of 365 Days, and 6 Hours nearly, which exceeded the *Civil Year* by 6 Hours each Year, and conſequently in four Years exceeded it by one whole Day; he ordered that to every fourth Year there ſhould be one Day added, and ſo make it conſiſt of 366 Days, by which means the *Civil* and *Solar Years* were reduced pretty near to an Equality. This additional Day was put in the month of *February*, and becauſe in the common Year, the twenty fourth Day of *February* was called by the *Romans*, the ſixth of the *Kalends* of *March*, therefore he ordering that this Day ſhould be added after the twenty fourth Day of *February*, and called by the ſame Name; there happened every fourth Year two Sixths of the *Kalends* of *March*, and hence that Year was called *Biſſextile* or *Leap Year*. This way is ſtill retained, and made uſe of by us.

16. But

16. But the true Length of the Year being 365 Days, 5 Hours, and 49 Minutes nearly, and by the *Julian* Account 365 Days and 6 Hours; 'tis plain the *Civil Year* exceeds the *Solar* by 11 Minutes yearly. Consequently if the *Sun* any Year enter the *Equinoctial* on the twentieth Day of *March* at Noon, the next Year, he will enter the *Equinoctial* the same Day, 11 Minutes before Noon, the next, 22 Minutes before Noon, and so on. Consequently in 131 Years the *Solar* will anticipate the *Civil Year*, by one whole Day; and so either *Equinox* will not happen always on the same Day of the *Civil Year*, but be carried in a Retrograde Order thro' all the Days of it. This was what put Pope *Gregory* the XIII. upon reforming the *Julian* Kalendar; for finding that at the Time of the *Nicene Council*, when the Time of celebrating *Easter* was instituted, the vernal *Equinox* happened the twenty first Day of *March*; and by flowing continually backwards, it happened at his time, in the Year 1572, on the eleventh Day of *March*, anticipating it's former Time, by 10 whole Days; he ordered that these 10 Days should be taken out of the *Kalendar*, and the eleventh Day of *March* should be reckoned the twenty First; and to prevent the seasons of the Year from going any more backwards, as they were before, he ordered that every hundred Year of the *Christian Æra* (which according to the *Julian Kalendar* is *Bissextile*) should be a common Year, and so consist only of 365 Days; but this being too much, therefore every four hundred Year was to remain *Bissextile* or *Leap Year*. This form of the Year is receiv'd in *France*, *Spain*, *Germany*, *Italy*, and other Countries that allow of the Pope's Authority; as also in *Holland*, and several other places where the reformed Religion is profess'd. But the *British* and other Reformed

northern Nations still retain the *Julian* form, which is called *Old Stile*, and the *Gregorian*, *New Stile*.

17. A *Kalendar* is a regular Disposition of the Days in the *Civil Year*, into Months and Weeks; each Day of every Week being distinguished from another by one of the first seven Letters of the Alphabet, *viz.* A, B, C, D, E, F, G. Beginning at the first of *January*, to it is annexed the Letter A, to the second the Letter B, to the third C, and so on to the seventh, to which is annexed the Letter G; and beginning again with the Letters, to the eighth is annexed A, to the ninth B, to the tenth C, and so on thro' the rest of the Days of the Year, each of them having one of these Letters annexed to it. Hence 'tis plain that whatever Letter is placed against any Day of any Week; that Letter will be placed against that Day thro' the whole Year: thus if the first Day of *January*, against which stands the Letter A, be a *Sunday*; then all the Days in the *Kalendar* having the Letter A standing against them, will be *Sundays*. Also if the fourth Day of *January*, against which stands the Letter D, be a *Sunday*, then all the Days in the *Kalendar*, having D, annexed to them will be *Sundays*. That Letter which answers to the *Sundays* throughout the Year, is called the *Dominical* or *Sunday Letter*, for that Year.

But since the *Common Year* consists of 365 Days, if that be divided by seven, the Quotient will be 52 Weeks, and one Day over; and since if nothing remained, then whatever Day of the Week the Year began on, the same Day of the Week would be the first Day of each succeeding Year; 'tis plain that whatever Day of the Week any Year begins on, the same Day of the Week will be the last Day of the Year; and consequently, if the first Day of *January*, to which is annexed the Letter A, be *Sunday*, the last Day of the Year

Year will be *Sunday*, and the first of the next will be *Monday*, and the first *Sunday* of the Year will fall on the seventh Day, to which is annexed the Letter G, which therefore will be the *Dominical Letter* all that Year; and since the Year began on *Monday*, it will also end on *Monday*, and the first Day of the next Year will be *Tuesday*; consequently the first *Sunday* will fall on the sixth Day, to which is annexed F, which therefore will be the *Dominical Letter* all that Year. And the same way the *Dominical Letter* the Year following will be E, and for the next D; and in this retrograde order the *Dominical Letter* is carried successively thro' the seven, after which it begins again.

18. From what has been said 'tis plain, that if the Year consisted of 365 Days exactly, after a Period of seven Years, the same Day of each Month would fall on the same Day of the Week. But because every fourth Year is *Bissextile*; consisting of 366 Days, which is equal to 52 Weeks, and 2 Days; therefore if that Year begins on a *Sunday*, it will end on *Monday*, and the next will begin on *Tuesday*, and the first *Sunday* of that Year will fall on the sixth Day of *January*, to which is annex'd the Letter F, which will be the *Dominical Letter* for the Year following the *Leap Year*, whose *Dominical Letter* was A. And since the *Bissextile* or *Leap Year*, returns every fourth Year, 'tis plain the Series of *Dominical Letters* will be interrupted, and will not return till after four times Seven, or twenty eight Years. And hence arises the Cycle of twenty eight Years called the *Solar Cycle*, which being compleated the Days of the Month return in the same order to the same Day of the Week.

19. And since in every *Leap Year*, the *Intercalary* Day is placed between the twenty third and twenty fourth Day of *February*, and so makes

two twenty fourths of *February*; which in the *Kalendar* are esteemed as one and the same Day, and have the same Letter affixed to them, and which by our way of reckoning are called the twenty fourth and twenty fifth Day of *February*; 'tis plain the order of the *Dominical Letter* will at that time be interrupted, and the succeeding Letter will take place; thus if in a *Leap Year* the first of *January* be *Sunday*, and consequently the *Dominical Letter* A; the twenty fourth Day of *February*, will fall upon a *Friday*, and the twenty fifth on a *Saturday*; and since both these Days are mark'd in the *Kalendar* with the same Letter F; the following Day, which is *Sunday*, will be mark'd with G, which Letter will mark out all the *Sundays*, and consequently be the *Dominical Letter*, the remaining part of the Year. And hence it is that every *Leap Year* has two *Dominical Letters*, the first of which serves from the beginning of the Year to the twenty fourth or twenty fifth Day of *February*, and then the other takes place, and serves for the rest of the Year.

20. The first Year of the *Solar Cycle* was plac'd in a *Leap Year*, having for it's *Dominical Letters* G and F, whence the *Dominical Letter* for the second is E, for the third D, for the fourth C; and the fifth Year of the *Cycle* is again *Bissextile*, whose *Dominical Letters* are B and A, consequently the *Dominical Letter* for the sixth Year is G, and so on, as in the following Table which shows the *Dominical Letter* for every Year in the *Cycle*.

1	G F	5	B A	9	D C	13	F E	17	A G	21	C B	25	E D
2	E	6	G	10	B	14	D	18	F	22	A	26	C
3	D	7	F	11	A	15	C	19	E	23	G	27	B
4	C	8	E	12	G	16	B	20	D	24	F	28	A

Whence

Whence 'tis plain, that by knowing the Year of the *Cycle*, we can find the *Dominical Letter* anſwering thereto from the Table. Now ſince the firſt Year of the *Chriſtian Æra* happen'd on the tenth Year of the *Cycle*, and conſequently 9 Years of the *Cycle* were elaps'd before the *Chriſtian Æra* commenced; therefore to find the Year of the *Solar Cycle* for any Year of the *Chriſtian Æra*, and the *Dominical Letter* belonging to it; we muſt add 9 to the given Year and divide the Sum by 28; then the Quotient will ſhow how many compleat *Cycles* has paſt ſince the firſt Year of the *Solar Cycle*, that the *Chriſtian Æra* commenc'd in, and the Remainder, if there be any, will ſhow the current Year of the *Cycle*; but if there be no Remainder then the Year is the laſt, or twenty eighth, Year of the current *Solar Cycle*; and having found the Year of the *Cycle*, we have the *Dominical Letter* anſwering it from the preceeding Table.

Example. Suppoſe it were required to find what Year of the *Solar Cycle* the Year 1734 is, and the *Dominical Letter* belonging to it.

Firſt, I add 9 to the given Year and the Sum is 1743, which divided by 28, the Quotient 62 ſhows that there are 62 compleat *Cycles* elaps'd, ſince the firſt Year of that *Cycle* in which the *Chriſtian Æra* commenced; and the Remainder 7 ſhows that the Year 1734 is the ſeventh Year of the current *Cycle*; then looking in the preceeding Table, for the ſeventh Year of the *Cycle*, I find the *Dominical Letter* anſwering thereto is F.

21. Since the Revolutions of the *Sun* and *Moon* are found conſtantly to be the ſame, the *Moon* moving with about thirteen Times the velocity of the *Sun*; it follows, that after a certain Number of Revolutions, they muſt meet again in the ſame Point of the Heavens they did ſome time before,

which by *Meton* the *Athenian*, was ſaid to be 19 Years juſt; after the expiration of which Time the *new* and *full Moons* were ſuppoſed to happen on the ſame Day and time of that Day, and in the ſame Month, they did 19 Years before that. This *Cycle* is from it's Author called the *Metonic Cycle*; alſo 'tis called the *Lunar Cycle*.

22. This *Cycle* began 1 Year before the commencement of the *Chriſtian Æra*, and conſequently to find what Year of the *Cycle* any Year in the *Chriſtian Æra* is; we muſt to the given Year add 1, and divide the ſum by 19; then the Quotient will ſhow how many *Cycles* have revolv'd ſince the commencement of the *Chriſtian Æra*, and the Remainder will ſhew what Year of the *Cycle* the preſent Year is; if there be no Remainder then the given Year will be the laſt or ninteenth Year of the *Cycle*. The Year of the *Cycle* anſwering to any given Year, is, for it's great Uſe in determining the Times of the *new* and *full Moon*, and thereby knowing what Day of the Month *Eaſter Day* falls upon, called the *Golden Number* or *Prime* for that Year.

Example. Required the *Golden Number* for the Year 1732.

Firſt, I add 1 to the given Year, and the ſum is 1733, this divided by 19, gives 91 for the Quotient, and 4 for the Remainder; which ſhows that there has revolved 91 compleat *Lunar Cycles* ſince the firſt Year of that *Cycle* in which the *Chriſtian Æra* commenced, and that the given Year is the fourth Year of the current *Cycle*, conſequently 4 is the *Prime* or *Golden Number* for the Year 1732.

23. It has been ſhown, at *Art*. 13. of this, that the *Solar Year* exceeds the *Lunar* by 11 Days nearly; conſequently if the Moon be New, or in conjunction with the Sun, on the laſt Day, or thirty firſt

first of *December* in any Year, on the last Day of the next Year it will be 11 Days past conjunction, and on the last Day of the following Year it will be 22 Days after new Moon; but because in the succeeding Year this amounts to 33 Days; and 30 Days being allowed for a compleat Moon: 'tis plain, in that Year there will have happened 13 Conjunctions, and the Moon will be 3 Days past Change on the last Day of it; consequently on the last Day of the next Year the Moon will be 14 Days past the Conjunction, and so continually increasing by eleven Days yearly, till after the end of 19 Years it will become the same as before. The Age of the Moon or number of Days past since the Conjunction, on the last Day of any Year is called the *Epact* for the succeeding Year.

24. Now since the *Epact* for the first Year of the *Lunar Cycle* was 11, the *Epact* for the Second will be 22, for the Third 3, for the Fourth 14, for the Fifth 25, and so on constantly increasing by 11; it follows that to find the *Epact* for any Year, we must multiply the *Golden Number* for that Year by 11, and divide the Product by 30, and the Quotient, if there be any, will show how many *Embolimean* or *Intercalary* Months has happened since the first Year of the current *Cycle*, and the Remainder will be the *Epact* for the given Year; or will show how many Days has elapsed between the last Day of the former Year and the immediately preceeding Conjunction.

Example. Required the *Epact* for the Year 1735.

First, By *Art.* 22. I find the *Golden Number* for the Year 1735 to be 7, which multiplied by 11, gives 77, and this divided by 30 gives 2 for the Quotient and 17 for the Remainder, and consequently there has been 2 *Intercalary* Months since the commencement of the current *Cycle* to the Year 1735, and 17 is the *Epact* for that Year, or it is the

the Age of the *Moon*, the last Day of *December* 1734.

25. Since by *Art.* 23. the *Epact* for any Year shews the Age of the *Moon* on the last Day of the preceeding Year, 'tis plain if to the *Epact* we add 1, the sum will be the Age of the Moon the first Day of that Year; but because the *Synodical Month*, or time betwen any two immediate Conjunctions, is equal to 29 Days and an Half, and *January* containing 31 Days; therefore if to the Age of the Moon on the first of *January* be added 1½ or (to avoid Fractions) 2 Days, the sum will be the Age of the *Moon* on the first of *February*; and because in common Years the Days in *January* and *February* taken together make 59; which is exactly equal to two intire Lunations, therefore the Age of the Moon on the first of *January* will be the same with it's Age on the first of *March*, and consequently to it's Age on the first of *January*, there is nothing added, in common Years, for it's Age on the first of *March*; but in *Leap Years* the sum of the Days in *January* and *February* being 60, which is more than two intire *Lunations* by 1 Day, it is evident that in this Case, we must add 1 Day to the *Moon's* Age on the first of *January*, and the sum will be it's Age on the first of *March*. And by the same way of reasoning it will appear, that to find the Age of the *Moon* on the first Day of any Month, we must add to it's Age on the first of *January* the following Numbers, *viz.* for *February* 2, for *March* 0, in common Years, and 1 in Leap Years, for *April* 2, for *May* 3, for *June* 4, for *July* 5, for *August* 6, for *September* 8, for *October* 8, for *November* 10, and for *December* 10. These additional Numbers are called the *Numbers* of the *Months*.

26. From

26. From what has been said in the two last Articles, there naturally follows this Rule for finding the *Age of the Moon* on any Day, of a given Year, *viz.* To the *Epact* for the given Year, add the Day of the Month and number of the Month, and if the sum be less than 30 it is the Age of the *Moon* required; but if it exceed 30 then take 30 from it and the Remainder is the *Moon*'s Age.

Example. Required the *Moon*'s Age on the 13 Day of *May* 1733.

First, by *Art.* 24. I find the *Epact* for that Year to be 25 to which adding 13 the Day of the given Month and 3 the Number of it, the sum is 41; from which taking 30 there remains 11, the *Moon*'s Age on the given Day.

27. Since the *Moon* takes 30 Days from one Conjunction with the Sun to the next following, 'tis plain she must be 15 Days old when *Full*, and 7½ when in the first *Quarter*; and 22½ Days old when in the last *Quarter*. Consequently to find in any Month of a given Year the Day of the *Moon's Change*, and when *Full*, and when in either *Quarter*, we have this *Rule*, *viz.* Assume any Day of that Month at Pleasure, and by the last *Art.* find the Age of the *Moon* on that Day; then if it be 15 the Moon will be *Full* that Day, and counting 7½ Days backwards and forwards from that Day, we'll have the Times of the first and last *Quarters*, and by counting backwards and forwards from it, 15 Days we'll have the Times of the last and next *Change*. But if the Age of the *Moon* be greater then 15, then take 15 from it and the Remainder will show how many Days has run since last Full Moon. So counting those backwards we'll have the Day the last *Full Moon* happen'd on; and by knowing that we can find the Days of the *Change* and either *Quarter* as before. Again, if the Age of the *Moon* on the assumed Day be less then 15, then

then take that from 15, and the Remainder will ſhow how many Days are to run till the next *Full Moon*; and therefore counting ſo many forwards, we will have the Day of the *Full Moon*, by which we may find the Days of the *Change*, and either *Quarter* as above.

Example. Required the Times of *Full Moon*, *New Moon*, and firſt and laſt *Quarters* in *October* 1734.

Firſt, I aſſume any Day at Pleaſure, ſuppoſe the tenth of that Month; then by the laſt *Art.* I find the *Moon*'s Age on that Day to be 24 Days, from which taking 15 there remains 9, the Number of Days ſince the laſt *Full Moon*; therefore counting ſo many Days backwards, I find the *Full Moon* happens on the firſt Day of that Month, and counting 7½ Days forwards from that I find that the laſt *Quarter* happens on the ninth Day; then from the firſt Day, on which the *Full Moon* happens, counting 15 Days forwards, I find that the *Change* falls on the 16 Day, and reckoning 7½ Days forward from that, I find that the firſt *Quarter* falls on the twenty fourth Day.

28. When the *Moon* is in *Conjunction* with the *Sun*, then they both come to the Meridian at the ſame time; but the *Moon* moving ſtill Eaſterly with a Velocity much greater than that of the *Sun*, 'tis evident that when the *Sun* comes on the Meridian the next Day, the *Moon* will be on the Eaſt ſide of it, and conſequently cannot be upon the Meridian till ſome time after the *Sun*; and becauſe ſhe compleats her Revolution in 30 Days, therefore in that time, the difference of time between the *Sun* and *Moon*'s being on the Meridian will run thro' the whole 24 Hours: and hence by obſerving any Day how long Time the *Moon* takes to be upon the Meridian after the *Sun*, we may by this find the Age of the *Moon* that Day, making the following Propoſition, *viz.* As 24 Hours, the whole difference

difference of Time, is to 30 Days, the whole Number of Days from *Change* to *Change*, so is the observed difference of Time on any Day, to the Days run since the last Change, or the Age of the *Moon* at that time.

Example. Suppose on any Day the *Moon* is observed to be upon the Meridian 5 Hours after the *Sun*; Required the Age of the *Moon* at that time. Make it, as 24 is to 30, so is 5 to 6¼; consequently the *Moon* is 6¼ Days old at the time of observation.

29. The *Moon* moving round her Orbit, or 360 Degrees, in 30 Days, she must move 12 Degrees in 1 Day; but since her Motion is from West to East, and any heavenly Body, 15 Degrees to the Eastward of another being 1 Hour later of coming to the Meridian than that other; therefore making it as 15 Degrees is to 1 Hour, so is 12 Degrees to ⅘ of an Hour, or 48 Minutes; we find that the *Moon* is always 48 Minutes later of coming to the Meridian any Day than she was the Day before; and because she comes on the Meridian at the same Time with the *Sun* on the Day of her *Change*; therefore to find her *Southing*, or time of her coming on the Meridian, any Day, we must first find her Age (by *Art.* 26.) for that Day, then this multiplied by 48, will give the Minutes of difference of Time between the *Sun* and *Moon*'s coming on the Meridian; which divided by 60, will show how many Hours and Minutes the *Moon* is later of coming on the Meridian than the Sun; and counting so many forwards from twelve of the Day, we have the Time of the *Moon's Southing*. If the Hours and Minutes found as above be less than 12, then that will be the Time of the *Moon's Southing after Noon*; but if greater than 12, then take 12 from them, and the Remainder will be the Time of the *Moon's Southing* in the *Morning*.

Example. Required the Time of the *Moon's Southing* on the 12th of *October* 1732.

First, (By *Art.* 26.) I find the Age of the *Moon* that Day to be 4 Days; which multiplied by 48 gives 192 Minutes, for the difference of Time between the *Sun* and *Moon*'s coming to the Meridian that Day; and this divided by 60 gives 3 Hours and 12 Minutes; which being less than 12 Hours, is the Time of the *Moon's Southing after Noon.*

Example 2. Required the Time of the *Moon's Southing* the 21st Day of *May* 1733.

First, (by *Art.* 26.) I find the *Moon*'s Age that Day to be 19 Days, which multiplied by 48 gives 912 Minutes, the difference of Time between the *Sun* and *Moon*'s being on the Meridian that Day, and this reduced makes 15 Hours and 12 Minutes; from which taking 12, there remains 3 Hours 12 Minutes, which shews that on the 21st of *May* 1733. the *Moon* comes on the Meridian, at 12 Minutes past 3 in the *Morning.*

30. It was said at *Art.* 20. of this, that the first Year of the *Solar Cycle* was *Leap Year*; consequently the fifth must be *Leap Year*, and the ninth must also be *Leap Year*; but the *Christian Æra* commencing on the tenth Year of the *Solar Cycle*, therefore the first Year of that was the first after *Leap Year*, and the fourth was *Leap Year*, also the eighth, twelfth, sixteenth, *&c.* were *Leap Years*; whence to find whether any proposed Year of the *Christian Æra* be *Leap Year*, or how many it is past the last *Leap Year*; we must divide the proposed Year by 4, and if nothing remain, then the proposed Year is *Leap Year*; but if any thing remain, that will show how many Years has past since last *Leap Year.*

Example. Requir'd whether the Year 1730 be *Leap Year*, or how many since last *Leap Year.*

I divide

I divide the proposed Year 1730 by 4, and there remains 2, so I conculde that the Year 1730 is the second after *Leap Year*.

31. It has been shown at *Art.* 17. of this, that to every Day of the Year there is annexed one of the first seven Letters of the Alphabet, beginning with A, which is always annexed to the first of *January*, and in any common Year, the Letter annexed to the first *Sunday* of *January* is called the *Dominical Letter* for that Year; but each *Leap Year* having two *Dominical Letters* (by *Art.* 19.) the first of which serves from the beginning of the Year to the twenty-fourth or twenty fifth of *February*, and the other for the rest of the Year; consequently the *Dominical Letter* for any common Year, will shew what Day of *January* the first *Sunday* of that Year happens upon, reckoning from A (which is annexed to the first of *January*) according to the natural Order of the Letters, and in any *Leap Year* the first of it's two *Dominical Letters* will shew what Day of *January* the first *Sunday* of that Year falls on, counting from A, as above; thus in the Year 1730, the *Dominical Letter* is D, so counting from A, *viz.* making A one, B two, C three, and D four, I find that the first *Sunday* of that Year falls on the fourth Day of *January*; and by knowing what Day of *January* the first *Sunday* of any Year falls on, we may know what Day of the Week the first Day of that Year falls upon, by counting so many Days back from *Sunday*; thus, since in the Year 1730, the first *Sunday* falls upon the fourth of *January*; therefore the third will be *Saturday*, the second *Friday*, and the first *Thursday*; consequently the Year 1730 begins upon *Thursday*. From what has been said, there ariseth the following Rule for finding what Day of the Week any Day of a given Year falls upon, *viz.* Find the Day of the Week answering to the first of *January* that

Year; then add together the Days contained in each Month from the beginning of the Year to the Month in which the proposed Day is, and to this add the Day of the given Month: *Lastly*, Divide this Sum by 7, and if nothing remain, then the Day of the Week, preceeding that Day which answers to the first of *January* that Year, is the Day answering to the proposed Day; but if any thing remain, then counting so many forward (beginning with that Day, the first of *January* falls on) we shall have the Day of the Week, the proposed Day falls upon. *Note*, The Days contained in each Month, are as follows, *viz. January* 31, *February* 28 in common Years, and 29 in *Leap Years*, *March* 31, *April* 30, *May* 31, *June* 30, *July* 31, *August* 31, *September* 30, *October* 31, *November* 30, *December* 31.

Example. Required what Day of the Week the eighth of *July* 1730 falls upon.

First, By the preceeding Rule in this *Article*, I find that the first of *January* 1730 falls upon a *Thursday*; then to the Numbers, 31, 28, 31, 30, 31, 30, answering to the elapsed Months, I add 8 the Day of the given Month, and the Sum 189 divided by 7, there remains nothing, so I conclude that the eighth of *July* 1730 falls upon a *Wednesday*.

Example 2. Required what Day of the Week the twenty first of *March* 1730 falls upon.

By proceeding as in the last Example, I find after Division that 3 Remains, and the Year beginning upon a *Thursday*, therefore counting *Thursday* 1, *Friday* 2, and *Saturday* 3, I find that the proposed Day falls upon *Saturday*.

32. According to the Decree of the *Nicene Council* (which is followed by the Church of *England*) the *Sunday* after the fourteenth Day of that *Moon* which happens after the twenty first of *March* inclusively, *i. e.* after the commencement of the

twenty

twenty first of *March*, is *Easter Sunday*. And since the fourteenth Day of that *Moon*, or the *Paschal Full Moon* can never happen before the twenty first of *March*, nor after the eighteenth of *April*; therefore Easter Day can never happen sooner than the twenty second of *March*, nor later than the twenty fifth of *April*. Now to find what Day of *March* or *April*, *Easter Day* falls upon in any Year, we have from the foregoing *Articles*, the following Rule, *viz.* *First*, (by *Art*. 26.) find the Age of the *Moon* on the twenty first of *March* that Year, and if it be 14, then by the last *Article* find the Day of the Week answering to it, and the *Sunday* following is *Easter Day*; but if the *Moon's* Age on the twenty first of *March* be not 14, then reckon forward to the Day in which her Age is 14, and by the last *Article*, find the Day of the Week answering to that Day, and reckoning forward to the next *Sunday*, we shall have the Day required.

Example. Required when *Easter Day* happens in the Year 1730.

First, I find (by *Art*. 26.) that the Age of the *Moon* on the twenty first of *March* 1730, is 13; consequently counting 1 forward, I find that the 14 Day of the *Moon*, or the *Paschal Full Moon*, happens on the twenty second Day of *March*; then (by *Art*. 31.) I find that the twenty second of *March* 1730, is *Sunday*; therefore counting forwards to the next *Sunday*, which is *Easter Day*, I find it happens on the twenty ninth of *March*. *Note*, In *Leap Years*, instead of the twenty first of *March* you must use the twentieth; because in these Years *February* is increased by 1 Day.

33. From the *Cycles* of the *Sun* and *Moon* (explained in *Art*. 18. and 21.) multiplied into one another, there arises another *Cycle* of 532 Years, called the *Victorian* or *Dionysian Cycle*, from *Dionysius*

ſius it's Author; after the compleating of which, not only the *New Moons* and *Full Moons* return to the ſame Day of the Month nearly; but likewiſe the Days of every Month return to the ſame Days of the Week; and conſequently the *Dominical Letters*, and all the *Moveable Feaſts*, return in the ſame Order: whence this *Cycle* is called *the Great Paſchal Cycle*. Now, becauſe the *Chriſtian Æra* commenced on the 457th Year of the *Cycle*; therefore to find the Year of the *Dionyſian Period* for any Year of the *Chriſtian Æra*, we have the following Rule, *viz.* To the current Year of the *Chriſtian Æra*, add 458, and divide the Sum by 532; then the Quotient will ſhew how many *Periods* has paſt ſince the beginning of that in which the *Chriſtian Æra* commenced, and the Remainder will ſhew the Year of the *Dionyſian Period* anſwering to the given Year.

Example. Required the Year of the *Dionyſian Period*, for the Year of *Chriſt* 1733.

Firſt, I add to 1733 the Number 457, and the Sum is 2190; then I divide this by 532, and the Quotient is 4, and Remainder 62; conſequently there has paſt 4 *Dionyſian Periods* ſince the beginning of that in which the *Chriſtian Æra* commenced, and the given Year is the 62d of the *Current Cycle*.

34. Beſides the *Cycles* of the *Sun* and *Moon*, there is another *Cycle* conſiſting of 15 Years, called the *Cycle of Indiction*, which hath no connection with the Celeſtial Motions, and which was made uſe of by the *Romans* for ſome *Civil* Purpoſes, and is ſtill uſed by the *Popes of Rome* in their *Bulls* and *Diplomas*. The Year before *the Birth of Chriſt* was the third Year of this *Cycle*; and conſequently to find the Year of *Indiction* for any Year in the *Chriſtian Æra*, we have this Rule, *viz.* to the given Year add 3, and divide the Sum

by

by 15, then if there be no Remainder, the given Year is the fifteenth of the *Indiction*; but if there be any Remainder that will ſhew what Year of the *Indiction* the given Year is; and the Quotient will ſhew how many compleat *Cycles of Indiction* has paſt ſince the firſt Year of that in which the *Chriſtian Æra* commenced.

Example. Required the Year of *Indiction*, for the Year 1733 of the *Chriſtian Æra.*

Firſt, I add 3 to the given Year, and the Sum is 1736; then I divide this Sum by 15, and the Quotient is 115, and Remainder 11. Conſequently there has been 115 compleat *Cycles of Indiction* from the firſt Year of that in which the *Chriſtian Æra* commenced, and the Year 1733, is the 11th Year of *Indiction.*

35. From the Multiplication of the three *Cycles*, *viz.* the *Solar* of 28 Years, the *Lunar* of 19, and that of *Indiction* of 15; ariſes a Period of 7980 Years, called the *Great Julian Period.* This is ſuppoſed to have begun 764 Years before the *Creation of the World*, and is not yet compleated; conſequently it muſt comprehend all the Actions that has happened from the beginning of the World; and ſince the Year before *Chriſt* was the 4713th Year of this *Period*, therefore to find what Year of the *Julian Period* any current Year is, we muſt to the given Year of *Chriſt*, add 4713, and the Sum will be the required Year of the *Julian Period.*

Example. Required what Year of the *Julian Period* anſwers to the current Year of *Chriſt* 1734.

To the given Year 1734, I add 4713, and the Sum 6447, ſhews that the current Year of *Chriſt* 1734, is the 6447th Year of the *Julian Period.*

36. As in the Heavens, there are certain Points from which *Aſtronomers* begin their Computations; ſo likewiſe there are certain Points of Time, from which, as *Roots*, *Chronological* Computations begin:

and

and all memorable Actions are recorded by *Historians* according to the Series of Years following these *Roots*, or fixed Points of Time, which are called *Epochas* or *Æras*. The most celebrated and best known to us, is the *Christian Æra*, which commenced on the first of *January*, immediately following the birth of *Christ*.

37. The most Ancient *Epocha*, is that of the Creation of the World; which commenced 3950 Years before *Christ*. The next to this is that of the *Deluge*, which began 2956 Years before *Christ*. Then follows the *Epocha* of the *Olympiads*, which was the most ancient and famous *Epocha* among the *Greeks*, and other *Eastern Nations*; each *Olympiad* contained 4 Years, and they had their Rise from certain Games that were celebrated by the *Grecians* every fourth Year; in honour of *Jupiter Olympius*, which were called *Olympick Games*. The beginning of this *Epocha*, is supposed to have been on the 777th Year before *Christ*, and in the 3936th Year of the *Julian Period*. The next *Epocha*, is that of the Building of *Rome*, which began about the End of the third Year of the *Sixth Olympaid*, 754 Years before *Christ*, and in the 3959th Year of the *Julian Period*. Then follows the *Æra of Nabonassar King of Babylon*, from the beginning of whose Reign it commenced. This *Æra* is famous among *Astronomers*, being made use of by *Ptolemy*, *Albategnus*, *&c.* as a proper *Æra* for computing the Motions of the Celestial Bodies from. It began according to *Ptolemy*, on the fourth of the *Kalends* of *March*, 747 Years before *Christ*, in the 3966th Year of the *Julian Period*, and in the seventh Year after the building of *Rome*, and in the second Year of the eighth *Olympaid*. The next is the *Epocha* of *Alexander the Great*, which commenced at his Death; and this happened about the middle of the Spring, in

in the first Year of the 114th *Olympaid*, 324 Years before *Christ*, in the 4390th Year of the *Julian Period*, and in the 424th Year of the *Æra of Nabonassar*. There are several other *Epochas* besides these already mentioned of less note, which I shall pass over, it not being the Design here to give a particular Description of all the *Epochas* and their several Uses, but only to give a general Account of the most remarkable among them.

38. Since by the Rotation of the *Earth* about it's Axis, the *Moon* appears to move quite round from *East* to *West* in 24 Hours; therefore in that Time she must past over all the Points in the *Compass*, and so must move from one Point to the next succeeding in 45 Minutes. Consequently in moving from the *North* Point to the *South*, she must take 12 Hours, and from the *North*, to the N *b* E, or from the *South* to the S *b* W 45 Minutes; also from the *North* to the N N E, or from the *South* to S S W, 1 Hour 30 Minutes; and so on as in the following Table.

Points	*h* ,, *m*	*Points*
N	12 ,, 00	S
N *b* E	0 ,, 45	S *b* W
N N E	1 ,, 30	S S W
N E *b* N	2 ,, 15	S W *b* S
N E	3 ,, 00	S W
N E *b* E	3 ,, 45	S W *b* W
E N E	4 ,, 30	W S W
E *b* N	5 ,, 15	W *b* S
E	6 ,, 00	W
E *b* S	6 ,, 45	W *b* N
E S E	7 ,, 30	W N W
S E *b* E	8 ,, 15	N W *b* W
S E	9 ,, 00	N W
S E *b* S	9 ,, 45	N W *b* N
S S E	10 ,, 30	N N W
S *b* E	11 ,, 15	N *b* W

39. The *Flux* and *Reflux*, or *Ebbing* and *Flowing* of the Seas, does constantly respect the Motion of the *Moon*, and in every place when the *Moon* is on a certain Point of the *Compass*, or at a certain Distance from the Meridian, it is then High Water at that Place; and since she is twice at the same Distance from the Meridian, or in two opposite Points of the *Compass*, in her diurnal Motion; therefore in most places there is a double Ebbing and Flowing in a little more than 24 Hours. There has been found by Observation, for the most remarkable Coasts, the Points on which the Moon is when it is high Water in each of them; as in the following Table.

A Table of the most remakable Sea Coasts, in an Alphabetical Order; shewing in each of them, the Points of the Compass, *the* Moon *must be on, when it is high Water.*

A.

At *Abarwark*, E N E and W S W.

At *Abermerick* and *Antwerp*, E and W.

At *Alborough*, S E *b* S, and N W *b* N.

At *Amsterdam* and *Armenties*, N E and S W.

At *Army*, N N E, and S S W.

B.

At *Beachy* and *Blacktail*, and before the Race of *Blanquet*, N and S.

At *Blackness* in *Bluet*, at *Bell Isle*, N N E, and S S W.

Without *Bluet*, and at *Berwick*, N E *b* N, and S W *b* S.

At the River *Bourdeaux*, the South Coast of *Britaigne*, the Coast of *Biscay*, and ~~at *Bookness*~~, N E, and S W.

At *Brest*, before the *Bass*, the River of *Bourdeaux* within the *Haven*, N E *b* E, and S W *b* W.

In the *Breesound*, *Bloy*, *Baltimore*, E N E, and W S W.

Before *Bremen*, and at *Blackney*, and in the Channel before *Bourdeaux*, E and W.

At *Bridgewater*, E S E, and W N W.

At *Bristol Key*, E *b* S, and W *b* N.

At *Bullen-deep*, S S E, and N N W.

C

Before the Haven of *Caen*, in the Chamber, between *Cripplesand* and the *Greyl*, and at *Culbot*, S *b* E, and N *b* W.

At *Caldy*, and in the Bay of *Carnarvan*, E *b* N, and W *b* S.

Without

Without *Calais*, at *Corpus Christi Point*, before and at *Camfer*, N N E, and S S W.

Between *Calais* and *Dover*, before *Conquet*, and at the *N. Cape*, N E, and S W.

At the *Caskets*, and at *Chamberness*, S E *b* S, and N W *b* N.

Between *Guernsey* and the *Caskets*, before *Cromer*, before the *Caskets* at *Guernsey*, at *Seven Clifts*, and at *Catness*, S E, and N W.

In the Chamber of *Rye*, N *b* E, and S *b* W.

Without the *Caskets*, in the Channel, S E *b* E, and N W *b* W.

At *Concalo*, E and W.

In *Condado*, *N* and S.

At *Cork*, *Calais*, Cape *Clear*, and in the *Creek*, E N E, and W S W.

At *Caws*, in the Foss of *Caen*, in *Calais Road*, and in *Chamberness Road*, S S E, and N N W.

D.

At *Dartmouth*, E and W.

At *Diep*, *Dover*, and in the *Downs*, S S E, and N N W.

At *Dover Pier*, and before *Dunkirk*, N and S.

At *Denbeigh* and *Downs*, in the Road, N E *b* N, and S W *b* S.

At *Dublin*, S E *b* E, and N W *b* W.

At *Dunbar*, S E, and N W.

At *Dungeness* and *Dunnose*, S E *b* S, and N W *b* *N*.

At *Dungersan*, E N E, and W S W.

E.

At *Edam*, N N E, and SSW.

At *Emden*, before the *Elve*, before the *Eyder*, and before *Euchusun*, N and S.

Before the *Eastern* and *Western Emes*, and *Engemonts*, S E, and N W.

F.

In the *Fair Isle Roads*, and at the *North Foreland*, S *b* E, and N *b* W.

At the *Frith*, and at the *S. Foreland*, S S E, and N N W.

Before the *Fen*, in the Channel, N N E, and S S W.

At *Flamborough* and *Bradlington*, N E, and S W.

On the Coast of *Flanders*, N and S.

Without the Banks of *Flanders*, N E, and S W.

At *Flushing*, N *b* E, and S *b* W.

Without *Fountney*, N E *b* N, and S W *b* S.

At the *Forn*, in *Foy*, at *Falmouth*, E *b* N, and W *b* S.

Without the *Fly*, S E *b* E, and N W *b* W.

Before the Coast of *Frizeland*, and the *Fly*, E S E, and W N W.

Between *Foy* and *Falmouth*, in the Channel, and at *Foulness*, E *b* S, W *b* N.

At *Frize*, and the *Fair Isle*, N W, and S E.

G.

In the Road of *Gibralter*, at *Graveling*, and before *Cherburgh*, N and S.

Before *Goree*, at *Guernsey*, and at *Gravesend*, N N E, and S S W.

At *Groin*, at *Gascoign*, and the Coast of *Galicia*, N E, and S W.

Thwart of *Guernsey*, in the Channel, S E *b* S, and N W *b* N.

H.

Before *Hamburgh*, at *Hull*, at the *Holms*, and before *Humber's Mouth*, E and W.

At *Hampton Key*, before the *Hever*, before *Horn*, N and S.

At *Harlem*, *Havre de Grace*, and *Homehead*, S E, and N W.

Before *Hartlepool*, N E, and S W.

At *St. Helens*, at *Harwich*, and without the Banks of *Harwich*, S S E, and N N W.

At *Humber*, E *b* N, and W *b* S.

Under *Holy Island*, and at *Horn*, N N E, and S S W.

At *Huntcliff-Foot*, N E *b* E, and S W *b* S.

I.

In all the Havens on the S. Coasts of *Ireland*, E *b* N, and W *b* S.

On the West Coast of *Ireland*, N E, and S W.

At *Jutland Islands*, N and S.

K.

At *Kelliers*, N E, and S W.

At *Kentish Knock*, N and S.

At *Kilduyn*, E S E, and W N W.

At *Kildrive*, S E, and N W.

At *Kingsale*, E N E, and W S W.

L.

At *Lambay*, S E *b* E, and N W *b* W.

At *Leith*, N and S.

At *Lynn*, E *b* S, and W *b* N.

At *Lisbon*, N E *b* N, and S W *b* S.

At the *Lizard*, by the Land, E S E, and W N W.

At *Leostoff*, and thwart of it without the Banks, S E *b* S, and N W *b* N.

In *Leostoff Road*, and *Longsand Head*, S S E, and N N W.

At *London*, N E, and S W.

At *Londey*, E and W.

Thwart of *Londey*, and before *Lynn*, E *b* N, and W *b* S.

M.

Within the *Maes*, at *Malden*, N *b* E, and S *b* W.

Before the *Maes*, and before *St. Matthews Point*, N E *b* E, and S W *b* W.

In *St. Magnes Sound*, and at the *Magnes Castle*, S E *b* E, and N W *b* W.

At the *Isle of Man*, S E, and N W.

Before *Margate*, S *b* E, and N *b* W.

In *Milford*, at *Moonless*, at *St. Maloes*, E *b* N, and W *b* S.

Between *Mousehole* and *Falmouth*, and in *Milford Haven*, E S E, and W N W.

In *Mousehole*, at *St. Matthews*, and within *Mounts Bay*, E N E, and W S W.

N.

Between the *Naze*, and *Warhead* of *Lower*, S *b* E, and N *b* W.

Before the River of *Nants*, N E, and S W.

At the *Needles*, at the *Isle of White*, S E *b* E, and N W *b* W.

At *Newcastle*, E *b* N, and W *b* S.

At *Newport*, half Tide, N and S.

At the West End of the *Nore*, N *b* E, and S *b* W.

Before *St. Nicholas*, E *b* S, and W *b* N.

All the Coast of *Normandy*, and *Picardy*, S S E, and N NW.

O.

At *Orfordness*, S E *b* S, and N W *b* N.

At *Orfordness*, without the Banks, and between *Orford* and *Orwell-Waves*, S S E, and N N W.

At *Orfordness*, within the Sands, S *b* E, and N *b* W.

At *Orkness*, N E, and S W.

At *Orkney*, S E, and N W.

P.

At *St. Paul's* in the Haven, E and W.

At the *Pens*, *Portbus*, and *Poictu*, N E, and S W.

In *Plymouth*, and before *St. Paul's*, E *b* N, and W *b* S.

Thwart of *Plymouth*, E S E, and W N W.

Before *Podessemek*, E *b* S, and W *b* N.

At the Race of *Portland*, S E, and N W.

At *Portsmouth*, half Tide, N and S.

Q.

At *Queenborough*, N and S.

S.

In the *Sleve*, between *Usham* and *Scilly*, at the *Shooe*, at the *Spitt*, at *Southampton*, and all long the *Swin*, N and S.

Upon the Coast of *Spain*, and in *Shetland*, N E, and SW.

At *Scilly*, in the *Sound*, *Scarburgh*, and at *Staples*, N E *b* E, and S W *b* W.

At *Seven Isles*, without the Haven, in the *Broad Sound*, E N E, and W S W.

At the Mouth of *Severn*, between *Scilly* and the *Lizard*, at the *Spurn* and *Stockton*, E *b* N, and W *b* S.

Without *Scilly*, in the Channel, and *Salcomb*, E and W.

At *Sedmouth*, and at the *Start*, E *b* S, and W *b* N.

Off the *Start* in the Channel, E S E. and W N W.

Within the *Seyn*, and before *Shelbergh*, and at *Seven Clifts*, S E, and N W.

At *Shoram*, S E *b* S, and N W *b* N.

At *Seyn Head*, S S E, and N N W.

T.

Within *Tervere*, N *b* E, and S *b* W.

Before *Tervere*, before the River of *Thames*, and at *Tinmouth*, N N E, and S S W.

Before the *Tres*, and *Tinmouth*, before the Bay of *Tinmouth*, N E, and S W.

At the Clifts of the *Texel*, E N E, and W S W.

In *Torbay*, and before the *Texel*, E and W.

In the Road of the *Texel*, E S E, and W N W.

At *Torgen*, S E *b* S, and N W *b* N.

U.

Before *Urek*, N and S.

At *Use*, N E, and S W.

Between *Ushant*, and the *Main*, N E *b* E, and S W *b* W.

St. Vallery, S S E, and N N W.

W.

At *Winchelsea*, N *b* E, and S *b* W.

At the *Weilings*, and from the West End of the *Wight*, N N E, and S S W.

Before

Before the *Weilings*, N E *b* N, and S W *b* S.

At *Whitby*, N E, and S W.

In the Sea of *Wales*, and *Severn*, E N E, and W S W.

In *Wales*, E *b* N, and W *b* S.

At *Wells*, at *Weymouth*, and at *Waterford*, E and W.

At *Weymouth Key*, E *b* S, and W *b* N.

At the *Ness*, by *Wieringhen*, at *Wintenton*, E S E, and W N W.

Thwart the *Isle of Wight*, in the Channel, all within the *Isle of Wight*, between the *Isle of Wight*, and *Beachy*, by the Shore, S E *b* E, and N W *b* W.

At the East End of *Wight*, and on *Wierington Flats*, S E and N W.

Y.

Before *Yarmouth*, N N E, and S S W.

At *Youghall*, E N E, and W S W.

At *Yarmouth*, S E *b* E, and N W *b* W.

In *Yarmouth Road*, in *Yarmouth Haven*, S S E, and N N W.

Z.

On the Coast of *Zealand*, N N E, and S S W.

In the *Ziercek Sea*, N E, and S W.

40. By knowing the Point of the *Compass*, the *Moon* is on when it is high Water at any place, we know by *Art.* 38. the Time she takes to move from the *Meridian* to that Point; and since we can find by *Art.* 29. the Time of the *Moon*'s coming on the *Meridian* any Day; therefore to find the Time of high Water at any place, and on any Day, we have this Rule, *viz.* To the Hours and Minutes of the *Moon*'s Southing (found by *Art.* 29.) add the Hours and Minutes answering to the Point of Flowing (found from the Table of *Art.* 38,) the Sum is the Time of full Sea requir'd; countingfrom Noon or Midnight

Example. Requir'd the Time of High Water at *Bristol Key*, on the tenth of *May* 1731.

First, By *Art.* 29. I find the *Moon* comes on the *Meridian* that Day, 48 Minutes past 12 at Night, then because by the Table in the last *Article*, the *Moon* must be on the E *b* S, or W *b* N Point of the *Compass* before it be high Water at *Bristol*; and since by the Table at *Art.* 38. she takes 6 Hours, 45 Minutes,

45 Minutes in moving from the *Meridian* to either of thefe Points; therefore to the 48 Minutes before found, I add 6 Hours, 45 Minutes, and the Sum is 7 Hours, 33 Minutes in the Morning, the Time of full Sea at *Briftol*, for the Day propofed, which is alfo the Time at Night, when it is full Sea again, that Day.

SECT. VI.

Concerning the Log-Line, *and* Compafs.

1. THE Method commonly made ufe of for meafuring the Ship's way at Sea, or how far fhe runs in a given fpace of Time, is by the *Log-Line*, and *Half-Minute Glafs*.

2. The *Log* is a flat piece of Wood, in fhape like a *Flounder*, having a piece of Lead faften'd to it's Bottom, which makes it ftand or fwim upright in the Water; to this *Log* is tied or faftened a long Line, which is called the *Log-Line*; and this is commonly divided into certain Spaces, each of which is, or ought to be, fuch a proportional Part of a nautical Mile (60 of which make a Degree of a great Circle on the Earth) as half a Minute (the Time allow'd for the Experiment) is of an Hour.

3. Thefe Spaces are called *Knots*, becaufe at the End of each them, there is a piece of Twine with Knots in it, inreeved between the Strands of the *Line*, which fhews how many of thefe Spaces or *Knots*, are run out during the half Minute. They commonly commence or begin to be counted, at the diftance of about 10 Fathom, or 60 Feet from the *Log*; that fo the *Log*, when it is hove over Board, may be out of the *Eddy* of the Ship's *Wake*

before

before they begin to count, and for the more ready discovery of this Point of Commencement, there is commonly fastened at it a piece of red Rag.

4. The Log being thus prepar'd, and hove over Board from the *Poop*, and the Line veer'd out (by the help of a Reel, that turns easily, and about which it is wound) as fast as the *Log* will carry it away, or rather as the Ship sails from it, will shew according to the Time of veering, how far the Ship has run in a given Time; and consequently her rate of sailing.

5. A Degree of a *Meridian*, which is a great Circle on the Earth, according to the exactest Measures, contains about 69.545 *English* Miles; and each Mile, by the Statute being 5280 Feet, therefore a Degree of a *Meridian* will be about 367200 Feet; whence the $\frac{1}{60}$ of that, *viz.* a Minute, or Nautical Mile, must contain 6120 standard Feet; consequently since $\frac{1}{2}$ Minute is the $\frac{1}{120}$ part of an Hour, and each *Knot* being the same part of a noutical Mile (by *Art.* 2.) it follows, that each *Knot* will contain the $\frac{1}{120}$ part of 6120 Feet, *viz.* 51 Feet.

6. Hence it is evident, that whatever number of *Knots* the Ship runs in half a Minute, the same number of Miles she will run in one Hour; supposing her to run with the same Degree of Velocity during that Time; and therefore it is the general Way to heave the *Log* every Hour, to know her rate of sailing; but if the force or direction of the Wind vary, and not continue the same during the whole Hour, or if there has been more Sail set, or any Sail handed, that so the Ship has run swifter or slower in any part of the Hour, than she did at the Time of heaving the *Log*; then there must be an Allowance made accordingly for it, and this must be according to the discretion of the Artist.

7. Some-

7. Sometimes when the Ship is before the Wind, and there is a great Sea ſetting after her, it will bring home the *Log*, and conſequently the Ship will ſail faſter than is given by the *Log*. In this Caſe it is uſual, if there be a very great Sea, to allow one Mile in ten, and leſs in proportion, if the Sea be not ſo great. But for the generality, the Ship's Way is really greater than that given by the *Log*; and therefore in order to have the Reckoning rather before than behind the Ship, (which is the ſafeſt way) it will be proper to make the Space on the *Log-Line* between *Knot* and *Knot*, to conſiſt of 50 Feet inſtead of 51. Some, upon the Suppoſition that 60 Miles makes a Degree on the Meridian, make the Diſtance between *Knot* and *Knot* 42 Feet; when at the ſame time, by common experience they are oblig'd to leſſen the *Half-Minute-Glaſs* by near 6 Seconds, making it to run only 24 Minutes nearly; which plainly is correcting one miſtake by another.

8. If the Space between *Knot* and *Knot* on the *Log-Line* ſhould happen to be too great in proportion to the *Half-Minute-Glaſs*, *viz.* greater than 50 Feet; then the Diſtance given by the *Log*, will be too ſhort, and if that ſpace be too ſmall, then the Diſtance run (given by the *Log*) will be too great; therefore to find the true Diſtance run in either Caſe, having meaſured the Diſtance between *Knot* and *Knot*, we have the following Proportion, *viz.*

As the true Diſtance 50 Feet, is to the meaſured Diſtance, ſo is the Miles of Diſtance given by the *Log*, to the true Diſtance in Miles that the Ship has run.

Example 1. Suppoſe a Ship runs at the rate of $6\frac{1}{4}$ *Knots* in half a Minute, but meaſuring the ſpace between *Knot* and *Knot*, I find it to be 56 Feet; Required the true Diſtance in Miles.

Making it as 50 *Feet*, is to 56 *Feet*, so is 6,25 *Knots* to 7 *Knots*; I find that the true rate of sailing is 7 Miles in the Hour.

Example 2. Suppose a Ship runs at the rate of 6½ *Knots* in half a Minute, but measuring the space between *Knot* and *Knot*, I find it to be only 44 Feet: Required the true rate of sailing.

Making it as 50 *Feet*, is to 44 *Feet*, so is 6.5 *Knots*, to 5.72 *Knots*; I find that the true rate of sailing is 5.72 Miles in the Hour.

9. Again, supposing the Distance between *Knot* and *Knot* on the *Log-Line* to be exactly 50 Feet, but that the *Glass* is not 30 Seconds; then if the *Glass* require longer time to run than 30 Seconds, the Distance given will be too great, if estimated by allowing 1 Mile for every *Knot* run, in the time the *Glass* runs; and on the contrary, if the *Glass*, require less time to run than 30 Seconds, it will give the Distance sail'd too small. Consequently to find the true Distance in either Case, we must measure the time the *Glass* requires to run out (by the Method in the following Article) then we have the following Proportion, *viz.*

As the number of Seconds the *Glass* runs, is to half a Minute, or 30 Seconds, so is the Distance given by the *Log*, to the true Distance.

Example 1. Suppose a Ship runs at the rate of 7½ *Knots* in the time the *Glass* runs, but measuring the *Glass*, I find it runs 34 Seconds: Required the true Distance sail'd.

Making it as 34 Seconds, is to 30 Seconds, so is 7.5, to 6.6; I find that the Ship sails at the rate of 6.6 Miles an Hour.

Example 2. Suppose a Ship runs at the rate of 6½ *Knots*, but measuring the *Glass*, I find it runs only 25 Seconds: Required the true rate of sailing.

Making

Making it as 25 *Seconds*, is to 30 *Seconds*, so is 6.5 *Knots*, to 7.8 *Knots*; I find that the true rate of sailing is 7.8 Miles an Hour.

10. In order to know how many Seconds the *Glass* runs, you may try it by a Watch or Clock, that vibrates Seconds; but if neither of these be at hand, then take a Line, and to the one end fastening a *Plummet*, hang the other upon a *Nail* or *Peg*, so as the Distance from the *Peg* to the Center of the *Plummet* be 39⅛ Inches: then this put into Motion will vibrate Seconds, *i. e.* every time it passes the Perpendicular you are to count one Second; consequently by observing the number of Vibrations that it makes during the time the *Glass* is running, we know how many Seconds the *Glass* runs.

11. If there be an Error both in the *Log-Line* and *Half-Minute-Glass*, *viz.* if the Distance between *Knot* and *Knot* on the *Log-Line*, be either greater or less than 50 Feet, and the *Glass* runs either more or less than 30 Seconds, then the finding of the Ships true Distance will be somewhat more complicate, and admit of three Cases, *viz.*

Case 1. If the *Glass* runs more than 30 Seconds, and the Distance between *Knot* and *Knot* be less than 50 Feet, then the Distance given by the *Log-Line*, *viz.* by allowing 1 Mile for each *Knot* the Ship sails while the *Glass* is runing, will always be greater than the true Distance; since either of these Errors give the Distance too great. Consequently to find the true rate of sailing, in this Case, we must first find (by *Art.* 8.) the Distance, on the supposition that the *Log-Line* is only wrong, and then with this (by *Art.* 9.) we shall find the true Distance.

Example. Suppose a Ship is found to run at the rate of 6 *Knots*; but examining the *Glass*, I find it runs 35 Seconds, and measuring the *Log-Line*, I

find the Distance between *Knot* and *Knot* to be but 46 Feet: Required the true Distance run.

First, By *Art.* 8. we have the following proportion, *viz.* As 50 *Feet* : 46 *Feet* : : 6 *Knots* : 5.52 *Knots*. Then by *Art.* 9. As 35 *Seconds* : 30 *Seconds* : : 5.52 *Knots* : 4.73 *Knots*. Consequently the true rate of sailing is 4.73 Miles an Hour.

Case 2. If the *Glass* be less than 30 Seconds, and the space between *Knot* and *Knot* be more than 50 Feet; then the Distance given by the *Log*, will always be less than the true Distance, since either of these Errors lessen the true Distance.

Example. Suppose a Ship is found to run at the rate of 7 *Knots*, but examining the *Glass*, I find it runs only 25 Seconds, and measuring the space between *Knot* and *Knot* on the *Log-Line*, I find it is 54 Feet: Required the true rate of sailing.

First, By *Art.* 9. As 25 *Seconds*: 30 *Seconds*: : 7 *Knots*: 8.4 *Knots*. Then by *Art.* 8. As 50 *Feet*: 54 *Feet*: : 8.4 *Knots*: 9.072 *Knots*. Consequently the true rate of sailing is 9.072 Miles an Hour.

Case 3. If the *Glass* runs more than 30 Seconds, and the space between *Knot* and *Knot* be greater than 50 Feet, or if the *Glass* runs less than 30 Seconds, and the space between *Knot* and *Knot* be less than 50 Feet; then since in either of these two Cases the effects of the Errors are contrary, 'tis plain the Distance will sometimes be too great and sometimes too little, according as the greater Quantity of the Error lies; as will be evident from the following Examples.

Example 1. Suppose a Ship is found to run at the rate of 9½ *Knots* per *Glass*, but examining the *Glass*, it is found to run 36 Seconds, and by measuring the space between *Knot* and *Knot*, it is found to be 58 Feet: Required the true rate of sailing.

First,

First, By *Art*. 8. As 50 *Feet* : 58 *Feet* :: 9.5 *Knots* : 11.02 *Knots*. Then by *Art*. 9. As 38 *Seconds* : 30 *Seconds* :: 11.02 *Knots* : 8.7 *Knots*. Consequently the Ship's true rate of sailing is 8.7 Miles an Hour.

Example 2. Suppose a Ship runs at the rate of 6 *Knots* per *Glass*; but examining the *Glass*, it is found to run only 20 Seconds, and by measuring the *Log-Line*, the Distance between *Knot* and *Knot* is found to be but 38 Feet: Required the true rate of sailing.

First, By *Art*. 8. As 50 *Feet*: 38 *Feet*:: 6 *Knots*: 4. 56 *Knots*. Then by *Art*. 9. As 20 *Seconds*: 30 *Seconds*:: 4. 56 *Knots*: 6. 84 *Knots*. Consequently the true rate of sailing is 6. 84 Miles an Hour.

But if in this Case it happen, that the time the *Glass* takes to run, be to the Distance between *Knot* and *Knot*, as 30, the Seconds in half a Minute, is to 50, the true Distance between *Knot* and *Knot*; then 'tis plain, that whatever number of Seconds the *Glass* consists of, and whatever number of Feet is contain'd between *Knot* and *Knot*; yet the Distance given by the *Log-Line*, will be the true Distance in Miles.

12. Though the Method of measuring the Ship's Way by the *Log-Line*, described in the foregoing Articles, be that which is now commonly made use of; yet it is subject to several Errors, and these pretty considerable. For first, the *Half-Minute* or *Quarter-Minute-Glasses* (by which, and the *Log*, the Ship's Way is determin'd) are seldom or never true, because dry and wet Weather have a great Influence on them; so that at one Time they may run more, and at another Time fewer than 30 Seconds, and 'tis evident that a small Error in the *Glass*, will cause a sensible one in the Ship's Way. Again, the chief Property of the *Log* is to have

it

it swim upright; or perpendicular to the *Horizon*; but this is too often wanting in *Logs*, because few Seamen examine whether it is so or not, and generally take it upon trust, being satisfied, if it weigh a little more at the Stern than the Head; and from this there flows an Error in the Reckoning, for if the *Log* does not swim upright, it will not hold Water, nor remain steady in the place where it is heav'd, since the least check of the Hand, in veering the Line will make it come up several *Feet*; this repeated will make the Errors become *Fathoms*, and perhaps *Knots*, which how insignificant soever they appear, are Miles and parts of Miles, and amount to a good deal in a long Voyage. Another inconvenience attending the *Log-Line* is it's stretching and shrinking; for when a new Line is first used, let it be ever so well stretched upon the Deck, and measured as true as possible, yet after weting it shrinks considerably; and consequently to be the better assur'd of the Ship's Way by the *Log-Line*, we ought to measure and alter the *Knots* on it every time before we use it; but this is seldom done oftner than once a Week, and sometimes not above once or twice in a whole Voyage; also when the Line is measured to it's greatest Degree of shrinking, it is generally left there; and when by much use, it comes to stretch again it is seldom or never mended, tho' it will stretch beyond what it first shrunk. These and many other Errors, too well known, attending that method of measuring the Ship's Way by the *Log-Line*, plainly answers for a great many Errors committed in Reckonings. So 'tis to be wish'd that either this Method were improved or amended, or that some other Method less subject to Error, were found out. There was a Machine sometime ago invented by Mr. *Henry de Saumarez*, of the Island of *Guernsey*, for measuring the Ship's Way, called the

Marine

Marine Surveyor; which is indeed less subject to Error than the *Log-Line*, and was found by several Experiments to answer the end much more exactly than the *Log-Line*; a Description of which may be seen in the *Philosophical Transactions* of the *Royal Society*, Vol. xxxiii. for the months of *November* and *December* 1725; and also in those for the months of *March* and *April* 1726; and for *March* and *April* 1729.

13. It was said at *Art.* 21. *Sect.* 3. that the Meridian and prime Vertical of any place cuts the Horizon in 4 Points, at 90 Degrees distance from one another, *viz.* the *North*, *South*, *East* and *West*; that part of the *Meridian* which extends itself from the place to the *North* point of the *Horizon*, is called the *North Line*; that which tends to the *South* point of the *Horizon*, is called the *South Line*; and that part of the *Prime Vertical* which extends towards the right Hand of the Observer, when his face is turn'd to the *North*, is called the *East Line*; and lastly, that part of the *Prime Vertical* which tends towards the left Hand, is called the *West Line*; the four Points in which these Lines meet the *Horizon*, are called the *Cardinal Points*.

14. In order to determine the *Course* of the *Winds*, and to discover their various Alterations or Shiftings; each Quadrant of the *Horizon* intercepted between the *Meridian* and *Prime Vertical*, is usually divided into eight equal Parts, and consequently the whole *Horizon* into thirty two; and the Lines drawn from the place on which the Observer standeth, to the points of Division in his *Horizon*, are called *Rumb Lines*, the four principal of which are those described in the preceeding Article, each of them having it's name from the cardinal Point in the *Horizon* towards which it tends; the rest of the *Rumb Lines* have their names compounded of the

the principal Lines on each side of them, as in the following Figure; and over which-soever of these Lines the course of the Wind is directed, that Wind takes it's name accordingly.

15. The Instrument commonly us'd at Sea for directing the Ship's Way, is called the *Mariners Compass*; which consists of a *Card* and two *Boxes*. The *Card* is a Circle made to represent the *Horizon*, whose Circumference is quartered and divided into Degrees, and also into thirty two equal Parts, by Lines drawn from the Center to the several points of Division, called *Points of the Compass*. On the back side of the *Card*, and just below the *South* and *North Line*, is fix'd a *Steel Needle*, with a *Brass Cupola*, or hollow Center in the middle, which is plac'd upon the end of a fine *Pin*, upon which the *Card* may easily turn about; the *Needle* is touch'd with a *Load-Stone*, by which a certain Virtue is infus'd into it, that makes it (and consequently the *South* and *North Line* on the *Card*, above it) hang nearly in the plain of the *Meridian*, by which means the *South and North Lines* on the *Card* produc'd, would meet the *Horizon* in the *South* and *North* Points; and consequently all the other Lines on the *Card* produc'd would meet the *Horizon* in their respective Points.

16. The *Card* is represented in the annexed Scheme, in which you may observe, that the capital Letters N, S, E, W, denote the four cardinal Points, *viz.* N the *North*, S the *South*, *&c.* and the small Letter *b* signifies the word *by*: the *Rumbs* in the middle between any two of the Cardinals, are express'd by the Letters denoting these Cardinals, that which denotes the Point lying in the *Meridian* having the precedence; thus the *Rumb* in the middle between the North and East is express'd N E, which is to be read *North East*; also

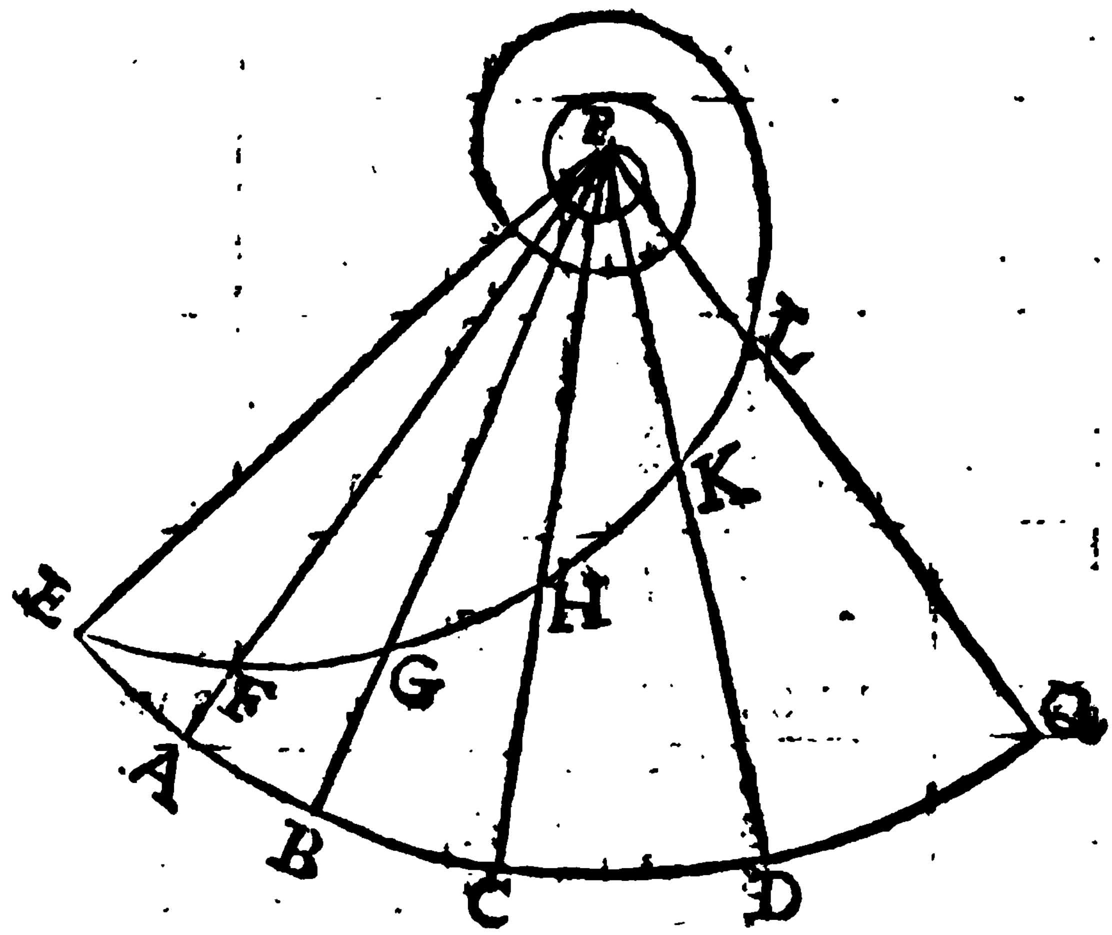
also S W denotes the *South West* Rumb, &c. the other Rumbs are express'd according to their

Situation with respect to these middle Rumbs, and the nearest Cardinals, as is plain from the annexed Scheme.

17. The *Card* is put into a round *Box*, made for it, having a Pin erected in the Middle, upon which the hollow Center of the *Needle* is fix'd, so as the *Card* may lie Horizontal, and easily vibrate according the Motion of the *Needle*; the *Box* is cover'd over with a smooth Glass, and is hung in a brass Hoop upon two cylindrical Pins, diametrically opposite to one another, and this Hoop is hung within another brass Circle, upon two Pins at right Angles with the former. These two Circles, and the *Box*, are placed in another square wooden *Box*, so that the innermost *Box*, and consequently the *Card*, may keep *Horizontal* which way soever the Ship heels.

18. Since the *Meridians* do all meet at the *Poles*, and there form certain Angles with one another; and since if we move never so little towards the *East* or *West*, from one place to another, we thereby change our *Meridian*, and in every place the *East* and *West Line* being perpendicular to the *Meridian*; it follows, that the *East* and *West Line* in the first Place, will not coincide with the *East* and *West Line* in the second, but be inclin'd to it, at a certain Angle: and consequently all the other *Rhomb Lines* at each Place, will be inclin'd to each other, they always forming the same Angles with the *Meridian*. Hence it follows that all *Rumbs*, except the four Cardinals, must be *Curves* or *Helispherical* Lines, always tending towards the *Pole*, and approaching it by infinite Gyrations or Turnings, but never falling into it. Thus let P be the Pole, F Q an Arch of the Equator, P E, P A, &c. Meridians, and E F G H K L any Rumb; then because the Angles P E F, P F G, &c. are by the Nature of the *Rumb Line* equal, it is evident that it will form a curve Line on the Surface of the Globe, always approaching the *Pole* P, but never falling

falling into it; for if it were possible for it to fall into the *Pole*; then it would follow, that the same Line



could cut an infinite Number of other Lines at equal Angles, in the same Point; which is absurd.

19. Because there are 32 *Rumbs* (or Points in the *Compass*) equally distant from one another, therefore the Angle contain'd between any two of them adjacent, will be 11°, 15′, *viz.* 1/32 Part of 360°; and so the Angle contain'd between the *Meridian* and the N *b* E, will be 11°, 15′; and between the *Meridian* and the N N E, will be 22°, 30′, and so of the rest, as in the following Table.

A Table of the Angles which every ¼ Point of the Compass makes with the Meridian.

North	South	Points	D.	M.	North	South
		¼	02	49		
		½	05	37		
		¾	08	26		
N*b*E	S*b*E	1	11	15	N*b*W	S*b*W
		1 ¼	14	04		
		1 ½	16	52		
		1 ¾	19	41		
NNE	SSE	2	22	30	NNW	SSW
		2 ¼	25	19		
		2 ½	28	07		
		2 ¾	30	56		
NE*b*N	SE*b*S	3	33	45	NW*b*N	SW*b*S
		3 ¼	36	34		
		3 ½	39	22		
		3 ¾	42	11		
NE	SE	4	45	00	NW	SW
		4 ¼	47	49		
		4 ½	50	37		
		4 ¾	53	26		
NE*b*E	SE*b*E	5	56	15	NW*b*W	SW*b*W
		5 ¼	59	04		
		5 ½	61	52		
		5 ¾	64	42		
ENE	ESE	6	67	30	WNW	WSW
		6 ¼	70	19		
		6 ½	73	07		
		6 ¾	75	56		
E*b*N	E*b*S	7	78	45	W*b*N	W*b*S
		7 ¼	81	34		
		7 ½	84	22		
		7 ¾	87	11		
East		8	90	00	*West*	

SECT. VII.

SECT. VII.

Of Plain Sailing.

1. THIS method of Sailing, ſuppoſes the Earth to be a *Plain*, and the *Meridians* parallel to one another; and likewiſe the Parallels of Latitude at equal Diſtance from one another, as they really are upon the Globe. Tho' this method be in itſelf evidently falſe; yet in a ſhort Run, and eſpecially near the *Equator*, an Account of the Ship's Way, may be kept by it tolerably well.

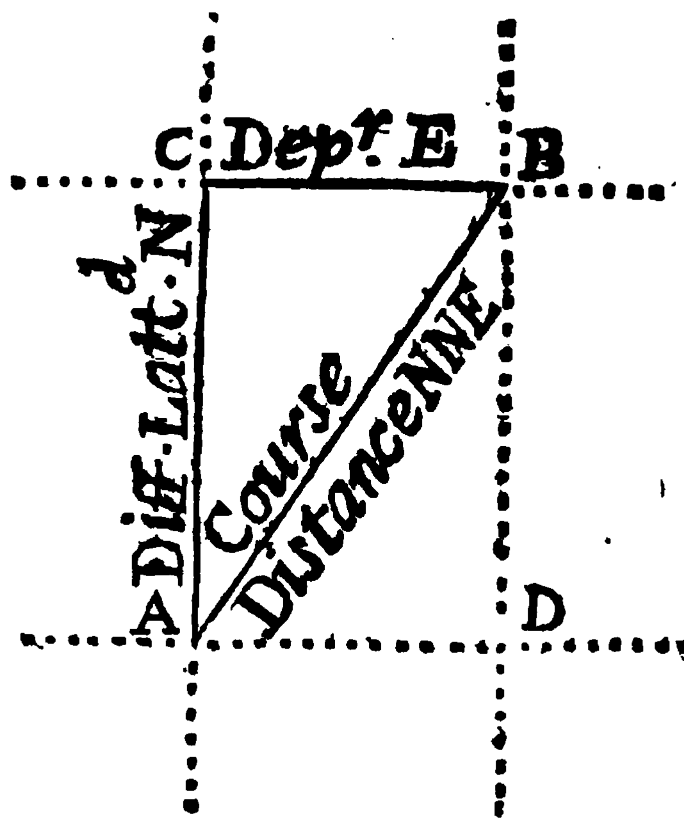
2. The Angle form'd by the *Meridian* and Rumb, that a Ship ſails upon, is called the Ship's *Courſe*. Thus if a Ship ſails on the N N E Rumb, then her *Courſe* will be 22°, 30′, and ſo of others.

3. The Diſtance between two places lying on the ſame Parallel counted in Miles of the *Equator*, or the Diſtance of one place from the *Meridian* of another, counted as above, on the Parallel paſſing over that place, is called *Meridional Diſtance*; which in *Plain Sailing*, goes under the name of *Departure*.

4. Let A denote a certain Point on the Earth's Surface, A C its *Meridian*, and A D the parallel of Latitude paſſing thro' it; and ſuppoſe a Ship to ſail from A on the N N E Rumb till ſhe arrive at B; and thro' B draw the Meridian B D (which according to the Principles of *Plain Sailing*, muſt be parallel to C A) and the parallel of Latitude B C; then the Length of A B, *viz.* how far the Ship has ſail'd upon the N N E Rumb, is called her *Diſtance*; A C or B D will be her *Difference of Latitude*, or Northing, C B will be her *Departure*, or Eaſting, and the Angle C A B will be the *Courſe*.

Hence

Hence it is plain, that the *Distance* sail'd, will always be greater than either the *Difference of Latitude*, or *Departure*, it being the Hypothenuse of a right Angled-Triangle, whereof the other two are the Legs; except the Ship sails either on a *Meridian*,



or a *parallel of Latitude*; for if the Ship sails on a *Meridian*, then it is plain, that her *Distance* will be just equal to her *Difference of Latitude*, and she will have no *Departure*; but if she sail on a Parallel, then her *Distance* will be the same with her *Departure*, and she will have no *Difference of Latititude*. It is evident also from the Scheme, that if the *Course* be less than 4 Points, or 45 Degrees, its Compliment, *viz.* the other *Oblique* Angle, will be greater than 45 Degrees, and so the *Difference of Latitude* will be greater than the *Departure*; but if the *Course* be greater than 4 Points, then the *Difference of Latitude* will be less than the *Departure*; and lastly, if the *Course* be just 4 Points, the *Difference of Latitude* will be equal to the *Departure*.

5. Since the Distance, Difference of Latitude, and Departure, form a right angled-Triangle, in which

which the *Oblique* Angle opposite to the Departure is the Course, and the other its Compliment; therefore having any two of these given, we can (by *Sect.* 2.) find the rest; and hence arises the Cases of *Plain Sailing*, which are as follows.

CASE 1.

Course and Distance given, to find Difference of Latitude and Departure.

Example.

Suppose a Ship sails from the Latitude of 30°, 25′ North, NNE, 32 Miles. Requir'd the Difference of Latitude and Departure, and the Latitude come to.

The Geometrical Construction of this Case, is the same as in *Case 3. of Right Angled-Trigonometry*,

the same Things being given in both; and from it we have the following Analogy, for finding the Departure, *viz.*

As Radius	- - - - - - - - - -	10.00000
to the Distance A C	- 32 - - - -	1.50515

so

so is the Sine of the Course A 22°, 30′ - 9.58284
to the Departure B C - - 12.25 - 1.08799
so the Ship has made 12.25 Miles of Departure Easterly, or has got so far to the Eastward of her Meridian. Then for the difference of Latitude, or Northing, the Ship has made, we have, by *Case* 3. *of Rectangular Trigonometry*, the following Analogy, *viz.*

As Radius - - - - - - - - - -		10.00000
is to the Distance A C - -	32 -	1.50515
so is the Co-Sine of Course A -	22°, 30′	9.96562
to the Difference of Lat. A B -	29.57 -	1.47077

so the Ship has differ'd her Latitude, or made of Northing 29.57 Minutes.

And since her former Latitude was North, and her difference of Latitude also North. Therefore,

To the Latitude sail'd from - -	30°, 25′ N
add the difference of Latitude -	00 , 29.57
and the Sum is the Lat. come to	30 , 54.57 N

By this Case is calculated the Table of Difference of Latitude, and Departure, to every Degree, Point, and quarter Point of the Compass; for the Distance from 1 to 100 Miles, at the end of this Section; the Use of which shall be there explain'd.

CASE 2.

Course and difference of Latitude given, to find Distance and Departure.

Example.

Suppose a Ship in the Latitude of 45°, 25′ North, sails N E *b* N ½ Easterly, till she come to the

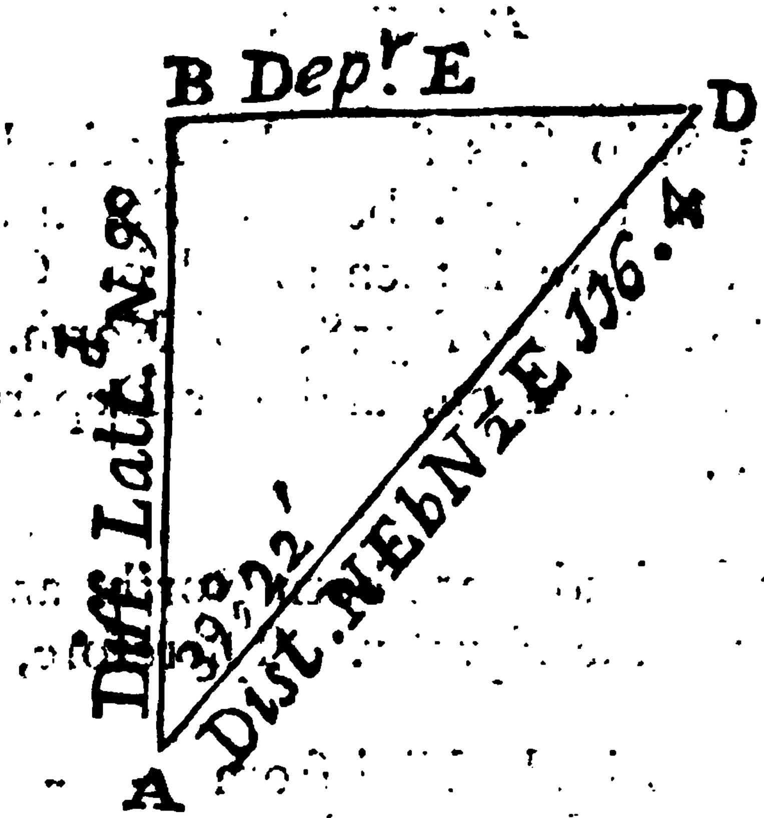
the Latitude of 46°, 55′ North. Required the Distance and Departure made good upon that Course.

Since both Latitudes are Northerly, and the Course also Northerly. Therefore,

From the Latitude come to - - - - -	46°, 55′
subtract the Latitude sail'd from - - - -	45 , 25
and there remains - - - - - -	01 , 30

the Difference of Latitude, equal to 90 Miles.

The Geometrical Construction of this Case, is the same with that of *Case* 1. *of Rectangular Trigo-*



nometry, and by it we have the following Analogy, for finding the Departure B D, *viz.*

As Radius - - - - - - - - - -		10.00000
is to the Diff. of Latitude A B -	90 -	1.95424
so is the Tangent of Course A -	39°, 22′	9.91404
to the Departure B D - - -	73.84	1.86828

so the Ship has got 73.84 Miles to the Eastward of her former Meridian.

Again, for the Distance AD, we have by *Case* 2. *of Rectangular Trigonometry*, the following proportion, *viz.*

As Radius - - - - - - - - - -		10.00000
is to the Secant of the Course	39°, 22′	10.11176
so is the Diff. of Latitude AB	90 -	1.95424
to the Distance AD - - - -	116.4 -	2.06600

CASE 3.

Difference of Latitude and Distance given, to find Course and Departure.

Example.

Suppose a Ship sails from the Latitude of 56°, 50′ North, on a Rumb between South and West, 126 Miles, and she is then found by Observation to be in the Latitude of 55°, 40′ North. Requir'd the Course she sail'd on, and her Departure from the Meridian.

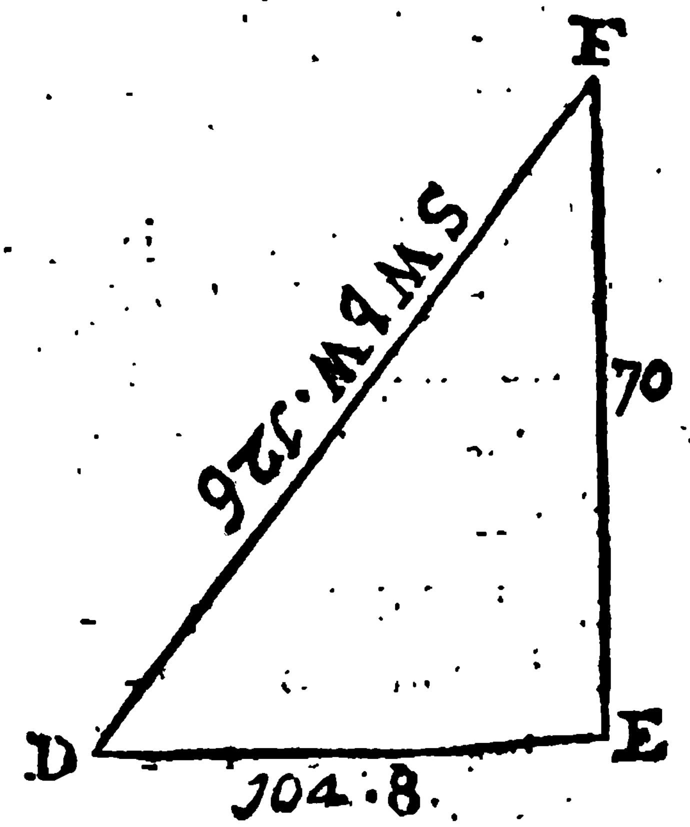
Since the Latitudes are both North, and the Ship sailing towards the *Equator*. Therefore,

From the Latitude sail'd from - -	56°, 50′
subtract the observ'd Latitude - -	55 , 40
and the Remainder - - - - - -	01 , 10

equal to 70 Miles, is the Difference of Latitude.

This

This Case is constructed the same Way as *Case* 5. *of Rectangular Trigonometry* and by it we have the



following proportion for finding the Angle of the Course F, *viz.*

As the Distance sail'd DF - 126	-	2.10037
is to Radius - - - - - - - -	-	10.00000
so is the Diff. of Latitude FE 70	-	1.84510
to the Co-Sine of the Course F 56°, 15′		9.74473

which, because she sails between South and West, will be South 56°, 15′ West, or SW*b*W. Then for the Departure, we have by *Case* 3. *of Rectangular Trigonometry*, the following proportion, *viz.*

As Radius - - - - - - - - - - - -		10.00000
is to the Distance sail'd DF -	126 -	2.10037
so is the Sine of the Course F -	56°, 15′	9.91985
to the Departure DE - - - -	104.8 -	2.02022

consequently she has made 104.8 Miles of Departure Westerly.

CASE 4.

Difference of Latitude and Departure given, to find Course and Distance.

Example.

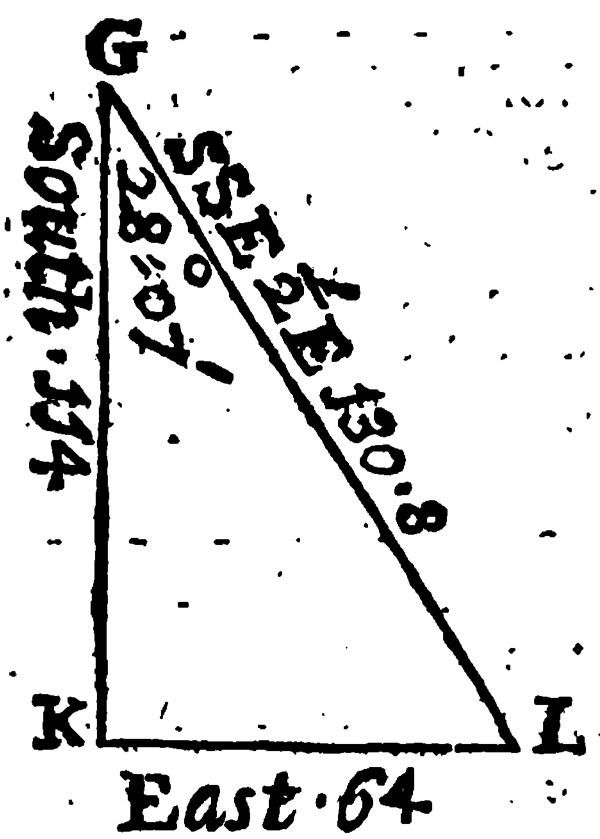
Suppose a Ship sails from the Latitude of 44°, 50′ North, between South and East, till she has made 64 Miles of Easting, and is then found by Observation to be in the Latitude of 42°, 56′ North. Requir'd the Course and Distance made good.

Since the Latitudes are both North, and the Ship sailing towards the *Equator*. Therefore,

From the Latitude sail'd from -	44°, 50′ N
take the Latitude come to -	42 , 56
and there Remains - - - - - -	01 , 54

equal to 114 Miles, the Difference of Latitude or Southing.

This Case is constructed the same Way as *Case 4. of Rectangular Trigonometry*, and by it we have the



following proportion to find the Course K G L, *viz.*

As

As the Diff. of Latitude GK 114 - - 2.05690
is to Radius - - - - - - - - - - 10.00000
so is the Departure KL - - 64 - 1.80618
to the Tang. of Course G - 29°, 19′ 9.74928
which because the Ship is sailing between South and East, will be South 29°, 19′ East or S S E ½ East nearly.

Then for the Distance, we shall have by *Case* 2. *of Rectangular Trigonometry*, the following Analogy, *viz.*

As Radius - - - - - - - - - 10.00000
is to the Diff. of Lat. GK 114 - - 2.05690
so is the Secant of the Course 29°, 19′ 10.05952
to the Distance GL - - 130.8 - 2.11642
consequently the Ship has sail'd on a S S E ½ East Course 130.8 Miles.

CASE 5.

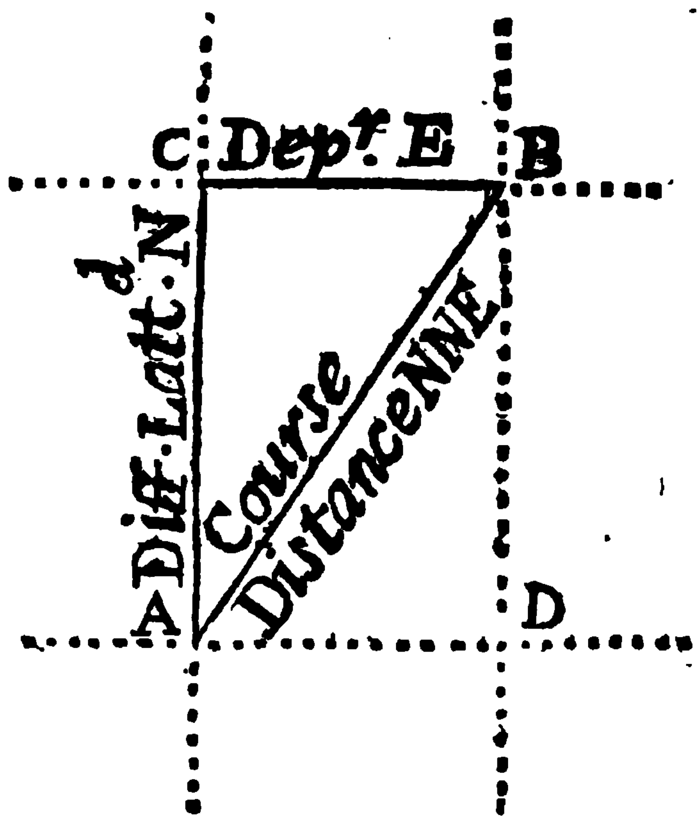
Distance and Departure given, to find Course and Difference of Latitude.

Example.

Suppose a Ship at Sea, sails from the Latitude of 34°, 24′ North, between North and West 124 Miles; and is found to have made of Westing 86 Miles. Required the Course steer'd, and the Difference of Latitude or Northing made good.

This

Hence it is plain, that the *Distance* sail'd, will always be greater than either the *Difference of Latitude*, or *Departure*, it being the Hypothenuse of a right Angled-Triangle, whereof the other two are the Legs; except the Ship sails either on a *Meridian*,



or a *parallel of Latitude*; for if the Ship sails on a *Meridian*, then it is plain, that her *Distance* will be just equal to her *Difference of Latitude*, and she will have no *Departure*; but if she sail on a Parallel, then her *Distance* will be the same with her *Departure*, and she will have no *Difference of Latititude*. It is evident also from the Scheme, that if the *Course* be less than 4 Points, or 45 Degrees, its Compliment, *viz.* the other *Oblique* Angle, will be greater than 45 Degrees, and so the *Difference of Latitude* will be greater than the *Departure*; but if the *Course* be greater than 4 Points, then the *Difference of Latitude* will be less than the *Departure*; and lastly, if the *Course* be just 4 Points, the *Difference of Latitude* will be equal to the *Departure*.

5. Since the Distance, Difference of Latitude, and Departure, form a right angled-Triangle, in which

ly. Hence to find the Latitude the Ship is in, since both Latitudes are North, and the Ship sailing from the *Equator*. Therefore,

To the Latitude sail'd from - - - - -	34°, 24′
add the Difference of Latitude - - - -	1 , 29
the sum is - - - - - - -	35 , 53

the Latitude the Ship is in North.

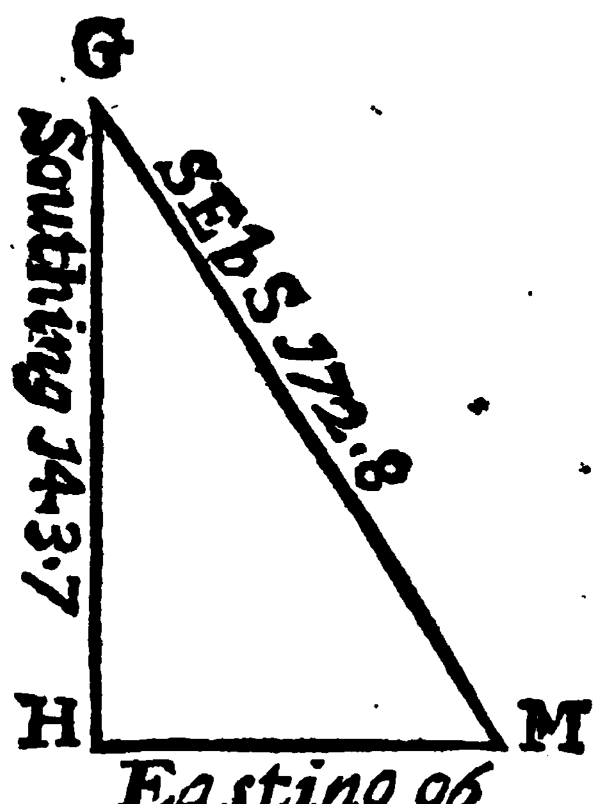
CASE. 6.

Course and Departure given, to find Distance and Difference of Latitude.

Example.

Suppose a Ship at Sea, in the Latitude of 24°, 30′ South, sails S E *b* S, till she has made of Easting 96 Miles. Required the Distance and Difference of Latitude made good on that Course.

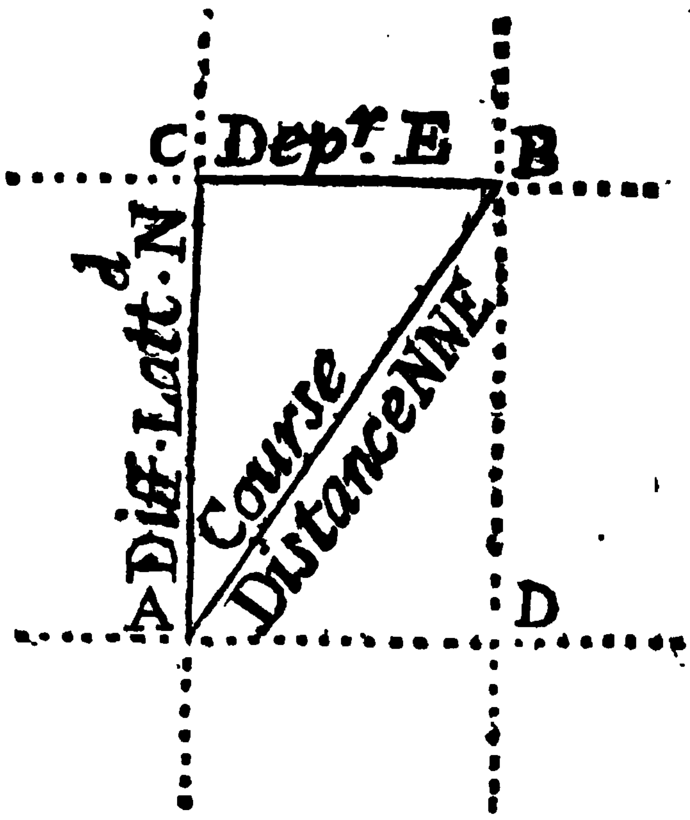
This Case is projected the same Way as *Case* 1. *of Rectangular Trigonometry*, and by *Case* 2. we have



the following proportion for finding the Distance, *viz.*

As

Hence it is plain, that the *Distance* ſail'd, will always be greater than either the *Difference of Latitude*, or *Departure*, it being the Hypothenuſe of a right Angled-Triangle, whereof the other two are the Legs; except the Ship ſails either on a *Meridian*,



or a *parallel of Latitude*; for if the Ship ſails on a *Meridian*, then it is plain, that her *Diſtance* will be juſt equal to her *Difference of Latitude*, and ſhe will have no *Departure*; but if ſhe ſail on a Parallel, then her *Diſtance* will be the ſame with her *Departure*, and ſhe will have no *Difference of Latititude*. It is evident alſo from the Scheme, that if the *Courſe* be leſs than 4 Points, or 45 Degrees, its Compliment, *viz.* the other *Oblique* Angle, will be greater than 45 Degrees, and ſo the *Difference of Latitude* will be greater than the *Departure*; but if the *Courſe* be greater than 4 Points, then the *Difference of Latitude* will be leſs than the *Departure*; and laſtly, if the *Courſe* be juſt 4 Points, the *Difference of Latitude* will be equal to the *Departure*.

5. Since the Diſtance, Difference of Latitude, and Departure, form a right angled-Triangle, in which

which the *Oblique* Angle opposite to the Departure is the Course, and the other its Compliment; therefore having any two of these given, we can (by *Sect.* 2.) find the rest; and hence arises the Cases of *Plain Sailing*, which are as follows.

CASE 1.

Course and Distance given, to find Difference of Latitude and Departure.

Example.

Suppose a Ship sails from the Latitude of 30°, 25' North, NNE, 32 Miles. Requir'd the Difference of Latitude and Departure, and the Latitude come to.

The Geometrical Construction of this Case, is the same as in *Case* 3. *of Right Angled-Trigonometry*,

the same Things being given in both; and from it we have the following Analogy, for finding the Departure, *viz.*

As Radius	- - - - - - - - -	10.00000
to the Distance A C	- 32 - - - -	1.50515

so

so is the Sine of the Course A 22°, 30′ - 9.58284
to the Departure B C - - 12.25 - 1.08799
so the Ship has made 12.25 Miles of Departure Easterly, or has got so far to the Eastward of her Meridian. Then for the difference of Latitude, or Northing, the Ship has made, we have, by *Case* 3. *of Rectangular Trigonometry*, the following Analogy, *viz.*

As Radius - - - - - - - - - -		10.00000
is to the Distance A C - -	32 -	1.50515
so is the Co-Sine of Course A -	22°, 30′	9.96562
to the Difference of Lat. A B -	29.57 -	1.47077

so the Ship has differ'd her Latitude, or made of Northing 29.57 Minutes.

And since her former Latitude was North, and her difference of Latitude also North. Therefore,

To the Latitude sail'd from - -	30°, 25′ N
add the difference of Latitude -	00 , 29.57
and the Sum is the Lat. come to	30 , 54.57 N

By this Case is calculated the Table of Difference of Latitude, and Departure, to every Degree, Point, and quarter Point of the Compass; for the Distance from 1 to 100 Miles, at the end of this Section; the Use of which shall be there explain'd.

CASE 2.

Course and difference of Latitude given, to find Distance and Departure.

Example.

Suppose a Ship in the Latitude of 45°, 25′ North, sails N E *b* N ½ Easterly, till she come to the

3. Course N W *b* W and Distance 48 Miles.
For Departure.

As Radius - - - - - - - - - -		10.00000
is to the Distance - - -	48 - -	1.68124
so is the Sine of the Course	56°, 15′	9.91985
to the Departure - - -	39.91 -	1.60109

For Difference of Latitude.

As Radius - - - - - - - - - -		10.00000
is to the Distance - - -	48 - -	1.68124
so is the Co-Sine of the Course	56°, 15′ -	9.74474
to the Diff. of Latitude -	26.67 -	1.42598

4. Course S *b* W ½ West and Distance 54 Miles.
For Departure.

As Radius - - - - - - - - - -		10.00000
is to the Distance - - -	54 - -	1.73239
so is the Sine of the Course -	16°, 52′ -	9.46262
to the Departure - - -	15.67 -	1.19501

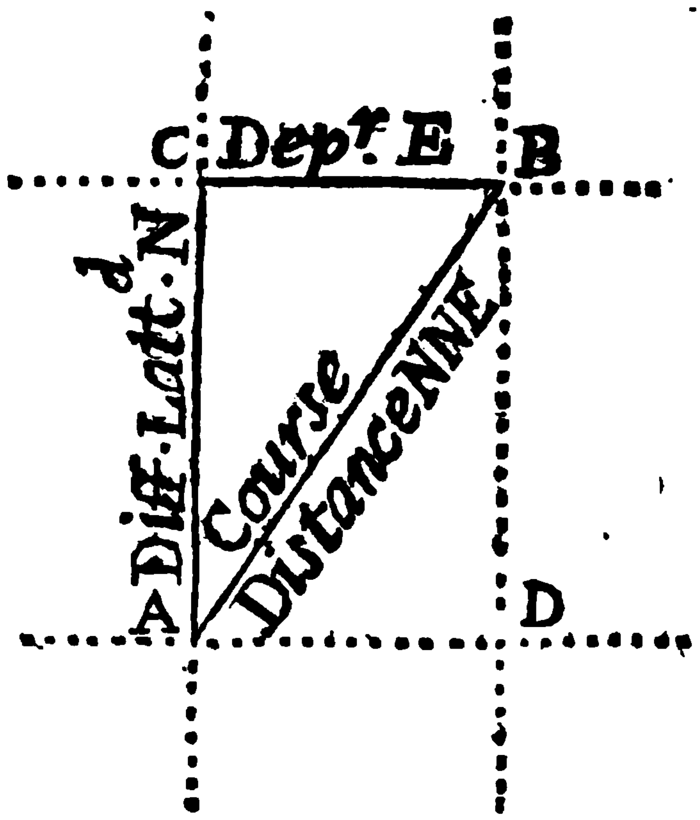
For Difference of Latitude.

As Radius - - - - - - - - - -		10.00000
is to the Distance - - -	54 - -	1.73239
so is the Co-Sine of the Course	16°, 52′	9.98090
to the Diff. of Latitude - -	51.67 -	1.71329

5. Course S E *b* S ½ East and Distance 74 Miles.
For Departure.

As Radius - - - - - -		10.00000
is to the Distance - -	74 - -	1.86923
so is the Sine of the Course	39°, 22′	9.80228
to the Departure - -	46.94 -	1.67151

Hence it is plain, that the *Distance* sail'd, will always be greater than either the *Difference of Latitude*, or *Departure*, it being the Hypothenuse of a right Angled-Triangle, whereof the other two are the Legs; except the Ship sails either on a *Meridian*,



or a *parallel of Latitude*; for if the Ship sails on a *Meridian*, then it is plain, that her *Distance* will be just equal to her *Difference of Latitude*, and she will have no *Departure*; but if she sail on a Parallel, then her *Distance* will be the same with her *Departure*, and she will have no *Difference of Latititude*. It is evident allso from the Scheme, that if the *Course* be less than 4 Points, or 45 Degrees, its Compliment, *viz.* the other *Oblique* Angle, will be greater than 45 Degrees, and so the *Difference of Latitude* will be greater than the *Departure*; but if the *Course* be greater than 4 Points, then the *Difference of Latitude* will be less than the *Departure*; and lastly, if the *Course* be just 4 Points, the *Difference of Latitude* will be equal to the *Departure*.

5. Since the Distance, Difference of Latitude, and Departure, form a right angled-Triangle, in which

which the *Oblique* Angle opposite to the Departure is the Course, and the other its Compliment; therefore having any two of these given, we can (by *Sect.* 2.) find the rest; and hence arises the Cases of *Plain Sailing*, which are as follows.

CASE I.

Course and Distance given, to find Difference of Latitude and Departure.

Example.

Suppose a Ship sails from the Latitude of 30°, 25' North, NNE, 32 Miles. Requir'd the Difference of Latitude and Departure, and the Latitude come to.

The Geometrical Construction of this Case, is the same as in *Case 3. of Right Angled-Trigonometry*,

the same Things being given in both; and from it we have the following Analogy, for finding the Departure, *viz.*

As Radius - - - - - - - - -		10.00000
to the Distance A C -	32 - - -	1.50515

so

As the Diff. of Latitude - -	96 -	1.98227
is to Radius - - - - -		10.00000
so is the Departure - -	97 -	1.98677
to the Tang. of the Course -	45°, 19′	10.00450

and.

As Radius - - - - - -		10.00000
is to the Diff. of Latitude -	96 -	1.98227
so is the Sec. of the Course	45°, 19′	10.15293
to the Distance - -	136.5 -	2.13520

whence the true Bearing and Distance of the intended Port is SE, 136.5 Miles.

8. In the following Table, computed by *Case* 1. *of Plain Sailing*, for the more ready working a Traverse, you may observe; that in the top Column of each Page are placed the Courses beginning at 1 Degree, and proceeding thro' the several Degrees, Points, and quarter Points, to 45 Degrees, the bottom Column beginning with 45°, where the upper ends and preceeding to 90 Degrees, the Degrees in the upper and lower Columns being the Compliments of one another. The two side Columns in each Page contains the Distances, *viz.* those on the left Hand contains the Distances from 1 to 50, and those on the right-hand Page contains the Distances from 50 to 100. The other intermediate Columns contains Differences of Latitude and Departures, answering to the Courses in the top and Distances in the side Columns. The use of this will be plain, from the following Example.

Example 1.

Suppose the Course to be SE*b*S ½ East, and Distance 48 Miles. Required Difference of Latitude and Departure.

First,

First, I look in the top Column for $3\frac{1}{2}$ Points (because it is less than 4 Points, or 45 Degrees) and in the side Column on the left-hand Page (because the Distance is less than 50) for the Distance 48; then below the $3\frac{1}{2}$ Points, and on the same line with 48, I find 37.1 for the Difference of Latitude, and 30.4 for the Departure.

Example 2.

Suppose the Course N E *b* E, and the Distance 76 Miles. Required Difference of Latitude and Departure.

First, I look in the bottom Column for the Course, *viz.* 5 Points (because it exceeds 4 Points or 45 Degrees) and in the side Column on the right-hand Page (because the Distance exceeds 50) for the Distance 76; then above the Course, and on the same Line with the Distance, I find 63.2 for the Departure, and 42.2 for the Difference of Latitude.

If the given Distance exceed the Limits of the Table, *i. e.* be greater than 100, then that Distance must be divided into two or more Parts, each of which must be less or equal to 100; then find as in the preceeding Examples, the Difference of Latitude and Departure for each Distance on the given Course, and the Sum of these Differences of Latitudes will be the Difference of Latitude required, also the Sum of the Departures, will be the Departure required.

Example 3.

Suppose the Course S W *b* S, and Distance 146 Miles. Required the Difference of Latitude and Departure.

First, I divide the given Diſtance into two, *viz.* 100 and 46; then the Differences of Latitude and Departures anſwering to theſe on a S W *b* S Courſe, found in the Table, will be as follows, *viz.*

Courſe	*Diſt.*	*Diff. of Lat.*	*Depar.*
S W *b* S	100	83.1	55.6
———	46	38.2	25.5
———	146	121.3	81.1

The Sum of the Differences of Latitude, *viz.* 121.3 is the Difference of Latitude required, and and the Sum of the Departures, *viz.* 81.1 is the Departure required.

After the ſame manner may a Traverſe be wrought by the Table, *viz.* by finding the Difference of Latitude and Departure (from the Table) to each Courſe and Diſtance, and ſetting them down in their proper Columns in the Traverſe Table, and then working as in the foregoing example of a Traverſe.

Example.

Suppoſe a Ship in the Latitude of 36°, 43′ North, ſails on the following Courſes, *viz.* S E *b* S, 56 Miles, S S E 42 Miles, S *b* W 64 Miles, and N E *b* N 40 Miles. Required the Courſe and Diſtance made good upon the whole, and the Latitude the Ship has come to.

First, I take from the Table, the Difference of Latitude and Departure belonging to each Courſe and Diſtance, and theſe ſet down in their proper Columns

Columns in the Traverse Table, will stand as follows.

Courses	*Distances*	*Diff. of Lat* N	*Diff. of Lat* S	*Departure* E	*Departure* W
S E *b* S	- - 56	——	46.6	31.1	——
S S E	- - - 43	——	39.7	16.5	——
S *b* W	- - - 64	——	62.8	——	12.5
N E *b* N	- - 40	33.3	——	22.2	——
		33.3	149.1	69.8	12.5
			33.3	12.5	
	Diff. of Lat.		115.8	57.3	*Dep.*

Whence it is plain, that the Difference of Latitude made good is 115.8 Miles, and the Departure is 57.3 Miles; then for the direct Course and Distance it will be, by *Case* 4. *of Plain Sailing*.

As the Diff. of Lat. - 115.8 - - 2.09968
is to Radius - - - - - 10.00000
so is the Departure - 57.3 - - 1.75815
to the Tang. of the Course 24°, 30′ - 9.65847
which, because the Ship is sailing between South and East, will be SSE ¼ East nearly. Again, for the Distance it will be
As Radius - - - - - - - - - 10.00000
is to the Diff. of Lat. - 115.8 - - 2.09968
so is the Sec. of the Course 24°, 30′ - 10.04098
to the Distance - - 138.3 - - - 2.14066

And since the Ship is sailing towards the Equator, consequently diminishing her Latitude, therefore,

From the Lat. sail'd from - - - -	36°, 43′ N
subtract the Diff. of Lat. - - -	1 , 55 S
and there remains - - - - - - -	34 , 48 N

the Latitude the Ship has come to.

A Large and very Useful

TABLE

OF

Difference of *Latitude* and *Departure*, in Minutes and Tenth Parts, to every *Degree* and *Quarter-Point* of the Compass, for the Exact Working of a *Traverse*.

Dist.	1 Deg. Lat.	1 Deg. Dep	2 Deg. Lat.	2 Deg. Dep	½ Point. Lat.	½ Point. Dep	3 Deg. Lat.	3 Deg. Lat.	4 Deg. Lat.	4 Deg. Dep.	5 Deg. Lat.	5 Deg. Dep	Dist.
1	01.0	00.0	01.0	00.0	01.0	00.0	01.0	00.0	01.0	00.1	01.0	00.1	1
2	[illegible]	[illegible]	02.0	00.1	02.0	00.1	02.0	00.1	02.0	00.1	02.0	00.2	2
3	03.0	00.1	03.0	00.1	03.0	00.1	03.0	00.2	03.0	00.2	03.0	00.3	3
4	04.0	00.1	04.0	00.1	04.0	00.2	04.0	00.2	04.0	00.3	04.0	00.3	4
5	05.0	00.1	05.0	00.2	05.0	00.2	05.0	00.3	05.0	00.3	05.0	00.4	5
6	06.0	00.1	06.0	00.2	06.0	00.3	06.0	00.3	06.0	00.4	06.0	00.5	6
7	07.0	00.1	07.0	00.2	07.0	00.3	07.0	00.4	07.0	00.5	07.0	00.6	7
8	08.0	00.1	08.0	00.3	[illegible]	00.4	08.0	00.4	08.0	00.6	08.0	00.7	8
9	09.0	00.2	09.0	00.3	09.0	00.4	09.0	00.5	09.0	00.6	09.0	00.8	9
10	10.0	00.2	10.0	00.4	10.0	00.5	10.0	00.5	10.0	00.7	10.0	00.9	10
11	[illegible]	00.2	11.0	00.4	11.0	00.5	11.0	00.6	11.0	00.8	11.0	01.0	11
12	12.0	00.2	12.0	[illegible]	12.0	[illegible]	[illegible]	00.6	[illegible]	00.8	12.0	[illegible]	12
13	[illegible]	00.2	13.0	[illegible]	13.0	[illegible]	[illegible]	00.7	[illegible]	00.9	12.9	[illegible]	13
14	14.0	00.2	14.0	[illegible]	14.0	[illegible]	[illegible]	00.7	[illegible]	01.0	13.9	[illegible]	14
15	[illegible]	00.3	[illegible]	[illegible]	15.0	[illegible]	15.0	00.8	[illegible]	01.0	14.9	[illegible]	15
16	16.0	00.3	16.0	00.6	16.0	00.8	16.0	00.8	16.0	01.1	15.9	01.4	16
17	17.0	00.3	17.0	00.6	17.0	00.8	17.0	00.9	17.0	01.2	16.9	01.5	17
18	18.0	00.3	18.0	00.6	18.0	00.9	18.0	00.5	17.9	01.3	17.9	01.6	18
19	19.0	00.3	19.0	00.7	19.0	00.9	19.0	01.0	18.9	01.3	18.9	01.7	19
20	20.1	00.4	20.0	00.7	20.0	00.0	20.0	01.0	19.9	01.4	19.9	01.7	20
21	21.0	00.4	21.0	00.7	21.0	01.0	21.0	01.1	20.9	01.5	20.9	01.8	21
22	22.0	00.4	22.0	00.8	24.0	01.1	22.0	01.1	21.9	01.5	21.9	01.9	22
23	23.0	[illegible]	23.0	00.8	23.0	01.1	23.0	01.2	[illegible]	01.6	22.9	02.0	23
24	24.0	00.4	24.0	00.8	24.0	01.2	24.0	01.3	23.9	01.7	23.9	02.1	24
25	25.0	00.4	25.0	00.9	25.0	01.2	25.0	01.3	24.9	01.7	24.9	02.2	25
26	26.0	00.5	26.0	00.9	26.0	01.3	26.0	01.4	25.9	01.8	25.9	02.3	26
27	27.0	00.5	27.0	00.9	27.0	01.3	27.0	01.4	[illegible]	[illegible]	26.9	02.4	27
28	28.0	00.5	28.0	01.0	28.0	01.4	28.0	01.5	[illegible]	[illegible]	27.9	02.4	28
29	29.0	00.5	29.0	01.0	29.0	01.4	29.0	01.5	28.9	02.0	28.9	02.5	29
30	30.0	00.5	30.0	01.1	30.0	01.5	30.0	01.6	29.9	02.1	29.9	02.6	30
31	31.0	00.5	31.0	01.1	30.9	01.5	31.0	01.6	30.9	02.2	30.9	02.7	31
32	32.0	00.6	32.0	01.1	31.9	01.6	31.9	01.7	31.9	02.2	31.9	02.8	32
33	33.0	00.6	33.0	01.2	32.9	01.6	32.9	01.7	32.9	02.3	32.9	02.9	33
34	34.0	00.6	34.0	01.2	[illegible]	01.7	33.9	01.8	33.9	02.4	33.9	03.0	34
35	35.0	00.6	35.0	01.2	[illegible]	01.7	34.9	01.8	34.9	02.4	34.9	03.1	35
36	36.0	00.6	36.0	01.3	35.9	01.8	35.9	01.9	35.9	02.5	35.9	03.1	36
37	37.0	00.7	37.0	01.3	36.9	01.8	36.9	01.9	36.9	02.6	36.9	03.2	37
38	38.0	00.7	38.0	01.3	37.9	01.9	37.9	02.0	37.9	02.7	37.9	03.3	38
39	39.0	00.7	39.0	01.4	38.9	01.9	38.9	02.0	38.9	02.7	38.9	03.4	39
40	40.0	00.7	40.0	01.4	39.9	02.0	39.9	02.1	39.9	02.8	39.8	03.5	40
41	41.0	00.7	41.0	01.4	40.9	02.0	40.9	02.1	40.9	02.9	40.8	03.6	41
42	42.0	00.7	42.0	01.5	41.9	02.1	41.9	02.2	41.9	02.9	41.8	03.7	42
43	43.0	00.8	43.0	01.5	42.9	02.1	42.9	02.2	42.9	03.0	42.8	03.7	43
44	44.0	00.8	44.0	01.5	43.9	02.2	43.9	02.3	43.9	03.1	43.8	03.8	44
45	45.0	00.8	45.0	01.6	44.9	02.2	44.9	02.4	44.9	03.1	44.8	03.9	45
46	46.0	00.8	46.0	01.6	45.9	02.3	45.9	02.4	45.9	03.2	45.8	04.0	46
47	47.0	00.8	47.0	01.6	46.9	02.3	46.9	02.5	46.9	03.3	46.8	04.1	47
48	48.0	00.8	48.0	01.7	47.9	02.3	47.9	02.5	47.9	03.4	47.8	04.2	48
49	49.0	00.9	49.0	01.7	48.9	02.4	48.9	02.6	48.9	03.4	48.8	04.3	49
50	50.0	00.9	50.0	01.8	49.9	02.4	49.9	02.6	49.9	03.5	49.8	01.4	50
Dist.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dist.
	89 Deg.		88 Deg.		¾ Point		87 Deg.		86 Deg.		85 Deg.		

Dist.	1 Deg. Lat.	1 Deg. Dep	2 Deg. Lat.	2 Deg. Dep	1/4 Point Lat.	1/4 Point Dep	3 Deg Lat.	3 Deg Dep	4 Deg. Lat.	4 Deg. Dep	5 Deg. Lat.	5 Deg. Dep	Dist.
51	51.0	00.9	51.0	01.9	50.9	02.5	50.9	02.7	50.9	03.6	50.8	04.4	51
52	52.0	00.9	52.0	01.8	51.9	02.5	51.9	02.7	51.9	03.6	51.8	04.5	52
53	53.0	00.9	53.0	01.8	52.9	02.6	52.9	02.8	52.9	03.7	52.8	04.6	53
54	54.0	00.9	54.0	01.9	53.9	02.6	53.9	02.8	53.9	03.8	53.8	04.7	54
55	55.0	01.0	55.0	01.9	54.9	02.7	54.9	02.9	54.9	03.8	54.8	04.8	55
56	56.0	01.0	56.0	02.0	55.9	02.7	55.9	02.9	55.9	03.9	55.8	04.9	56
57	57.0	01.0	57.0	02.0	56.9	02.8	56.9	03.0	56.9	04.0	56.8	05.0	57
58	58.0	01.0	58.0	02.0	57.9	02.8	57.9	03.0	57.8	04.1	57.8	05.1	58
59	59.0	01.0	59.0	02.1	58.9	02.9	58.9	03.1	58.8	04.1	58.8	05.2	59
60	60.0	01.0	60.0	02.1	59.9	02.9	59.9	03.1	59.8	04.2	59.8	05.2	60
61	61.0	01.1	61.0	02.1	60.9	03.0	60.9	03.2	60.8	04.3	60.8	05.3	61
62	62.0	01.1	62.0	02.2	61.9	03.0	61.9	03.3	61.8	04.3	61.8	05.4	62
63	63.0	01.1	63.0	02.2	62.9	03.1	62.9	03.3	62.8	04.4	62.8	05.5	63
64	64.0	01.1	64.0	02.2	63.9	03.1	63.9	03.4	63.8	04.5	63.8	05.6	64
65	65.0	01.1	65.0	02.3	64.9	03.2	64.9	03.4	64.8	04.5	64.7	05.7	65
66	66.0	01.1	66.0	02.3	65.9	03.2	65.9	03.5	65.8	04.6	65.7	05.8	66
67	67.0	01.2	67.0	02.3	66.9	03.3	66.9	03.5	66.8	04.7	66.7	05.9	67
68	68.0	01.2	67.9	02.4	67.9	03.3	67.9	03.6	67.8	04.7	67.7	05.9	68
69	69.0	01.2	68.9	02.4	68.9	03.4	68.9	03.6	68.8	04.8	68.7	06.0	69
70	70.0	01.2	69.9	02.4	69.9	03.4	69.9	03.7	69.8	04.9	69.7	06.1	70
71	71.0	01.2	70.9	02.5	70.9	03.5	70.9	03.7	70.8	05.0	70.7	06.2	71
72	72.0	01.3	71.9	02.5	71.9	03.5	71.9	03.8	71.8	05.0	71.7	06.3	72
73	73.0	01.3	72.9	02.5	72.9	03.6	72.9	03.8	72.8	05.1	72.7	06.4	73
74	74.0	01.3	73.9	02.6	73.9	03.6	73.9	03.9	73.8	05.2	73.7	06.5	74
75	75.0	01.3	74.9	02.6	74.9	03.7	74.9	03.9	74.8	05.2	74.7	06.6	75
76	76.0	01.3	75.9	02.7	75.9	03.7	75.9	04.0	75.8	05.3	75.7	06.6	76
77	77.0	01.3	76.9	02.7	76.9	03.8	76.9	04.0	76.8	05.4	76.7	06.7	77
78	78.0	01.4	77.9	02.7	77.9	03.8	77.9	04.1	77.8	05.5	77.7	06.8	78
79	79.0	01.4	78.9	02.8	78.9	03.9	78.9	04.1	78.8	05.5	78.7	06.9	79
80	80.0	01.4	79.9	02.8	79.9	03.9	79.9	04.2	79.8	05.6	79.7	07.0	80
81	81.0	01.4	80.9	02.8	80.9	04.0	80.9	04.2	80.8	05.7	80.7	07.1	81
82	82.0	01.4	81.9	02.9	81.9	04.0	81.9	04.3	81.8	05.7	81.7	07.2	82
83	83.0	01.4	82.9	02.9	82.9	04.1	82.9	04.4	82.8	05.8	82.7	07.3	83
84	84.0	01.5	83.9	02.9	83.9	04.1	83.9	04.4	83.8	05.9	83.7	07.3	84
85	85.0	01.5	84.9	03.0	84.9	04.2	84.9	04.5	84.8	05.9	84.7	07.4	85
86	86.0	01.5	85.9	03.0	85.9	04.2	85.9	04.5	85.8	06.0	85.7	07.5	86
87	87.0	01.5	86.9	03.0	86.9	04.3	86.9	04.6	86.8	06.1	86.7	07.6	87
88	88.0	01.5	87.9	03.1	87.9	04.3	87.9	04.6	87.8	06.2	87.7	07.7	88
89	89.0	01.5	88.9	03.1	88.9	04.4	88.9	04.7	88.8	06.2	88.7	07.8	89
90	90.0	01.6	89.9	03.1	89.9	04.4	89.9	04.7	89.8	06.3	89.7	07.9	90
91	91.0	01.6	90.9	03.2	90.9	04.5	90.9	04.8	90.8	06.4	90.7	08.0	91
92	92.0	01.6	91.9	03.2	91.9	04.5	91.9	04.8	91.8	06.4	91.6	08.0	92
93	93.0	01.6	92.9	03.2	92.9	04.6	92.9	04.9	92.8	06.5	92.6	08.1	93
94	94.0	01.6	93.9	03.3	93.9	04.6	93.9	04.9	93.8	06.6	93.6	08.2	94
95	95.0	01.6	94.9	03.3	94.9	04.7	94.9	05.0	94.8	06.6	94.6	08.3	95
96	96.0	01.7	95.9	03.4	95.9	04.7	95.9	05.0	95.8	06.7	95.6	08.4	96
97	97.0	01.7	96.9	03.4	96.9	04.8	96.9	05.1	96.8	06.8	96.6	08.5	97
98	98.0	01.7	97.9	03.4	97.9	04.8	97.9	05.1	97.8	06.9	97.6	08.6	98
99	99.0	01.7	98.9	03.5	98.9	04.9	98.9	05.2	98.8	06.9	98.6	08.7	99
100	100.0	01.7	99.9	03.5	99.9	04.9	99.9	05.2	99.8	07.0	99.6	08.7	100
Dist.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dist.
	89 Deg.		88 Deg.		7 3/4 Point		87 Deg.		86 Deg.		85 Deg.		

Dist.	½ Point Lat.	½ Point Dep	6 Deg. Lat.	6 Deg. Dep	7 Deg. Lat.	7 Deg. Dep	8 Deg. Lat.	8 Deg. Dep	¾ Point. Lat.	¾ Point. Dep	9 Deg. Lat.	9 Deg. Dep	Dist.
1	01.0	00.1	01.0	00.1	01.0	00.1	01.0	00.1	01.0	00.1	01.0	00.2	1
2	02.0	00.2	02.0	00.2	02.0	00.2	02.0	00.3	02.0	00.3	02.0	00.3	2
3	03.0	00.3	03.0	00.3	03.0	00.4	03.0	00.4	03.0	00.4	03.0	00.5	3
4	04.6	00.4	04.0	00.4	04.0	00.5	04.0	00.6	04.0	00.6	03.9	00.6	4
5	05.0	00.5	05.0	00.5	05.0	00.6	04.9	00.7	04.9	00.7	04.9	00.8	5
6	06.0	00.6	06.0	00.6	06.0	00.7	05.9	00.8	05.9	00.9	05.9	00.9	6
7	07.0	00.7	07.0	00.7	06.9	00.8	06.9	01.0	06.9	01.0	06.9	01.1	7
8	08.0	00.8	08.0	00.8	07.9	01.0	07.9	01.1	07.9	01.2	07.9	01.2	8
9	09.0	00.9	08.9	00.9	08.9	01.1	08.9	01.2	08.9	01.3	08.9	01.4	9
10	09.9	01.0	09.9	01.0	09.9	01.2	09.9	01.4	09.9	01.5	09.9	01.6	10
11	10.9	01.1	10.9	01.1	10.9	01.3	10.9	01.5	10.9	01.6	10.9	01.7	11
12	11.9	01.2	11.9	01.2	11.9	01.5	11.9	01.7	11.9	01.8	11.8	01.9	12
13	12.9	01.3	12.9	01.4	12.9	01.6	12.9	01.8	12.9	01.9	12.8	02.0	13
14	13.9	01.4	13.9	01.5	13.9	01.7	13.9	01.9	13.8	02.1	13.8	02.2	14
15	14.9	01.5	14.9	01.6	14.9	01.8	14.8	02.1	14.8	02.2	14.8	02.3	15
16	15.9	01.6	15.9	01.7	15.9	01.9	15.8	02.2	15.8	02.3	15.8	02.5	16
17	16.9	01.7	16.9	01.8	16.9	02.1	16.8	02.4	16.8	02.5	16.8	02.7	17
18	17.9	01.8	17.9	01.9	17.9	02.2	17.8	02.5	17.8	02.6	17.8	02.8	18
19	18.9	01.9	18.9	02.0	18.9	02.3	18.8	02.6	18.8	02.8	18.2	03.0	19
20	19.9	02.0	19.9	02.1	19.8	02.4	19.8	02.8	19.8	02.9	19.7	03.1	20
21	20.9	02.1	20.9	02.2	20.8	02.6	20.8	02.9	20.8	03.1	20.7	03.3	21
22	21.9	02.2	21.9	02.3	21.8	02.7	21.8	03.1	21.8	03.2	21.7	03.4	22
23	22.9	02.2	22.9	02.4	22.8	02.8	22.8	03.2	22.7	03.4	22.7	03.6	23
24	23.9	02.3	23.9	02.5	23.8	2.9	23.8	03.3	23.7	03.5	23.7	03.8	24
25	24.9	02.4	24.9	02.6	24.8	03.0	24.8	03.5	24.7	03.7	24.7	03.9	25
26	25.9	02.5	25.9	02.7	25.8	03.2	25.7	03.6	25.7	03.8	25.7	04.1	26
27	26.9	02.6	26.9	02.8	26.8	03.3	26.7	03.7	26.7	04.0	26.7	04.2	27
28	27.9	02.7	27.9	02.9	27.8	03.4	27.7	03.9	27.7	04.1	27.6	04.4	28
29	28.9	02.8	28.8	03.0	28.8	03.5	28.7	04.0	28.7	04.2	28.6	04.5	29
30	29.8	02.9	29.8	03.1	29.8	03.7	29.7	04.2	29.7	04.4	29.6	04.7	30
31	30.8	03.0	30.8	03.2	30.8	03.8	30.7	04.3	30.7	04.5	30.6	04.9	31
32	31.8	03.1	31.8	03.3	31.8	03.9	31.7	04.4	31.6	04.7	31.6	05.0	32
33	32.8	03.2	32.8	03.4	32.7	04.0	32.7	04.6	32.6	04.8	32.6	05.2	33
34	33.8	03.3	33.8	03.5	33.7	04.1	33.7	04.7	33.6	05.0	33.6	05.3	34
35	34.8	03.4	34.8	03.7	34.7	04.3	34.7	04.9	34.6	05.1	34.6	05.5	35
36	35.8	03.5	35.8	03.8	35.7	04.4	35.6	05.0	35.6	05.3	35.5	05.6	36
37	36.8	03.6	36.8	03.9	36.7	04.5	36.6	05.1	36.6	05.4	36.5	05.8	37
38	37.8	03.7	37.8	04.0	37.7	04.6	37.6	05.3	37.6	05.6	37.5	06.0	38
39	38.8	03.8	38.8	04.1	38.7	04.8	38.6	05.4	38.6	05.7	38.5	06.1	39
40	39.8	03.9	39.8	04.2	39.7	04.9	39.6	05.6	39.6	05.9	39.5	06.3	40
41	40.8	04.0	40.8	04.3	40.7	05.0	40.6	05.7	40.6	06.0	40.5	06.4	41
42	41.8	04.1	41.8	04.4	41.7	05.1	41.6	05.8	41.5	06.2	41.5	06.6	42
43	42.8	04.2	42.6	04.5	42.7	05.2	42.6	06.0	42.5	06.3	42.5	06.7	43
44	43.8	04.3	43.7	04.6	43.7	05.4	43.6	06.1	43.5	06.5	43.5	06.9	44
45	44.8	04.4	44.7	04.7	44.7	05.5	44.6	06.3	44.5	06.6	44.4	07.0	45
46	45.8	04.5	45.7	04.8	45.7	05.6	45.5	06.4	45.5	06.7	45.4	07.2	46
47	46.8	04.6	46.7	04.9	46.6	05.7	46.5	06.5	46.5	06.9	46.4	07.3	47
48	47.8	04.7	47.7	05.0	47.6	05.9	47.5	06.7	47.5	07.0	47.4	07.5	48
49	48.8	04.8	48.7	05.1	48.6	06.0	48.5	06.8	48.5	07.2	48.4	07.7	49
50	49.8	04.9	49.7	05.2	49.6	06.1	49.5	07.0	49.5	07.3	49.4	07.8	50
Dist.	Dep	Lat.	Dep.	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dist.
	7½ Point.		84 Deg.		83 Deg.		82 Deg.		7¼ Point.		81 Deg.		

Dist.	10 Deg. Lat.	10 Deg. Dep	11 Deg. Lat.	11 Deg. Dep	1 Point. Lat.	1 Point. Dep	12 Deg. Lat.	12 Deg. Dep	13 Deg. Lat.	13 Deg. Dep	14 Deg. Lat.	14 Deg. Dep	Dist.
1	01,0	00,2	01,0	00,2	01,0	00,2	01,0	00,2	01,0	00,	01,0	00,2	1
2	02,0	00,	02,0	00,4	02,0	00,4	0 ,0	00,4	01,9	00,4	01,9	00,5	2
3	02,9	00,5	02,9	00,6	0 ,9	00,6	02,9	00,6	02,9	00,7	02,9	00,7	3
4	03,9	0,7	03,9	00,8	03,9	00,8	03,9	00,8	03,9	00,9	03,9	01,0	4
5	04,9	00,	04,9	00,9	04,9	01,0	04,9	01,0	04,9	01,1	04,8	01,2	5
6	05,9	01,0	05,9	01,1	05,9	01,2	05,9	01,2	05,8	01,3	05,8	01,4	6
7	06,9	01,2	06,9	01,3	06,9	0 ,4	06,8	01,5	06,8	01,6	06,8	01,7	7
8	07,9	01,4	07,8	01,5	07,8	01,6	07,8	01,7	07,8	01,8	07,8	01,9	8
9	08,9	01,6	08,8	01,7	08,8	01,8	08,8	01,9	08,8	02,0	08,7	02,2	9
10	09,8	01,7	09,8	01,9	09,8	01,9	09,8	02,1	09,7	02,2	09,7	02,4	10
11	10,8	01,9	10,8	02,1	10,8	02,1	10,8	02,3	10,7	02,5	10,7	02,7	11
12	11,8	02,1	11,8	02,3	11,8	02,3	11,7	02,5	11,7	02,7	11,6	02,9	12
13	12,8	02,2	12,8	02,5	12,7	02,5	12,7	02,7	12,7	02,9	12,6	03,1	13
14	13,	02,4	13,7	02,7	13,7	02,7	13,7	02,9	13,6	03,1	13,6	03,3	14
15	14,8	02,6	14,7	02,9	14,7	02,9	14,7	03,1	14,6	03,4	14,5	03,6	15
16	15,7	02,8	15,7	03,0	15,7	03,1	15,6	03,3	15,6	03,6	15,5	03,9	16
17	16,7	02,5	16,7	03,2	16,7	03,3	16,6	03,5	16,6	03,8	16,5	04,1	17
18	17,7	03,1	17,7	03,4	17,7	03,6	17,6	03,7	17,5	04,0	17,5	04,4	18
19	18,7	03,3	18,6	03,6	18,6	03,7	18,6	03,9	18,5	04,2	18,4	04,6	19
20	19,7	03,5	19,6	03,8	19,6	03,9	19,6	04,2	19,5	04,5	19,4	04,8	20
21	20,7	03,6	20,6	04,0	20,6	04,1	20,5	04,4	20,5	04,7	20,4	05,1	21
22	21,7	03,8	21,6	04,2	21,6	04,3	21,5	04,6	21,4	04,9	21,3	05,3	22
23	22,6	04,0	22,6	04,4	22,6	04,5	22,5	04,8	22,4	05,2	22,3	05,6	23
24	23,6	04,2	23,6	04,6	23,5	04,7	23,5	05,0	23,4	05,4	23,3	05,8	24
25	24,6	04,3	24,5	01,8	24,5	04,9	24,4	05,2	24,3	05,6	24,3	06,0	25
26	25,6	04,5	25,5	05,0	25,5	05,1	25,4	05,4	25,3	05,8	25,2	06,3	26
27	26,6	04,7	26,5	05,1	26,5	05,3	26,4	05,6	26,3	06,1	26,2	06,5	27
28	27,6	04,9	27,5	05,3	27,5	05,5	27,4	05,8	27,3	06,3	27,2	06,8	28
29	28,6	05,0	28,5	05,5	28,4	05,7	28,4	06,0	28,2	06,5	28,1	07,0	29
30	29,5	05,2	29,4	05,7	29,4	05,8	29,3	06,2	29,2	06,7	29,1	07,3	30
31	30,5	05,4	30,4	05,0	30,4	06,0	30,3	06,4	30,2	07,0	30,1	07,5	31
32	31,5	05,5	31,4	06,1	31,4	06,2	31,3	06,6	31,2	07,2	31,0	07,7	32
33	32,5	05,7	32,4	06,3	32,4	06,4	32,3	06,9	32,1	07,4	32,0	08,0	33
34	33,5	05,9	33,4	06,5	33,3	06,6	33,2	07,1	33,1	07,6	33,0	08,2	34
35	34,5	06,1	34,4	06,7	34,3	06,2	34,2	07,3	34,1	07,9	34,0	08,5	35
36	35,4	06,	35,3	06,9	35,3	07,0	35,2	07,5	35,1	08,1	34,9	08,7	36
37	36,4	06,	36,3	07,1	36,3	07,2	36,2	07,7	36,0	08,3	35,9	09,0	37
38	37,4	06,	37,3	07,2	37,3	07,4	37,2	07,9	37,0	08,5	36,9	09,2	38
39	38,4	06,	38,3	07,4	38,2	07,6	38,1	08,1	38,0	08,8	37,8	09,4	39
40	39,4	06,9	39,3	07,6	39,2	07,8	39,1	08,3	39,0	09,0	38,8	09,7	40
41	40,4	07,1	40,2	07,8	40,2	08,0	40,1	08,5	39,9	09,2	39,8	09,9	41
42	41,4	07,3	41,2	08,0	41,2	08,2	41,1	08,7	40,9	09,4	40,7	10,2	42
43	42,3	07,5	42,2	08,2	42,2	08,4	42,1	08,9	41,9	09,7	41,7	10,4	43
44	43,3	07,7	43,2	08,4	43,1	08,6	43,0	09,1	42,9	09,9	42,7	10,6	44
45	44,3	07,8	44,2	08,6	44,1	08,8	44,0	09,4	43,8	10,1	43,7	11,0	45
46	45,3	08,0	45,2	08,8	45,1	09,0	45,0	09,6	44,8	10,3	44,6	11,1	46
47	46,3	08,1	46,1	09,0	46,1	09,2	46,0	09,8	45,8	10,6	45,6	11,4	47
48	47,3	08,3	47,1	09,2	47,1	09,4	47,0	10,0	46,8	10,8	46,6	11,6	48
49	48,3	08,5	48,1	09,3	48,1	09,6	48,9	10,2	47,7	11,0	47,5	11,9	49
50	49,2	08,7	49,1	09,5	49,0	00,8	49,0	10,4	48,7	11,2	48,5	12,1	50
Dist.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dist.
	80 Deg.		79 Deg.		7 Point		78 Deg.		77 Deg		76 Deg.		

Dist.	10 Deg. Lat.	Dep.	Dist.
51	50,2	08,8	51
52	51,2	09,0	52
53	52,2	09,2	53
54	53,2	09,4	54
55	54,2	09,5	55
56	55,1	09,7	56
57	56,1	09,9	57
58	57,1	10,1	58
59	58,1	10,2	59
60	59,1	10,4	60
61	60,1	10,6	61
62	61,1	10,8	62
63	62,0	10,9	63
64	63,0	11,1	64
65	64,0	11,3	65
66	65,0	11,5	66
67	66,0	11,6	67
68	67,0	11,8	68
69	68,0	12,0	69
70	68,9	12,2	70
71	69,9	12,3	71
72	70,9	12,5	72
73	71,9	12,7	73
74	72,9	12,8	74
75	73,9	13,0	75
76	74,8	13,2	76
77	75,8	13,4	77
78	76,8	13,5	78
79	77,8	13,7	79
80	78,8	13,9	80
81	79,8	14,1	81
82	80,8	14,2	82
83	81,7	14,4	83
84	82,7	14,6	84
85	83,7	14,8	85
86	84,7	14,9	86
87	85,7	15,1	87
88	86,7	15,3	88
89	87,6	15,4	89
90	88,6	15,6	90
91	89,6	15,8	91
92	90,6	16,0	92
93	91,6	16,1	93
94	92,6	16,3	94
95	93,5	16,5	95
96	74,5	16,7	96
97	95,5	16,8	97
98	96,5	17,0	98
99	97,5	17,	99
100	98,5	17,4	100
Dist.	Dep. 80 Deg	Lat.	Dist.

Dist.
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Dist.

	18 Deg.		
ep	Lat.	Dep	Dist.
,3	00,9	00,3	1
,6	01,9	00,6	2
,9	02,8	00,9	3
,1	03,8	01,2	4
,5	04,8	01,5	5
,7	05,7	01,8	6
,0	06,7	02,2	7
,3	07,6	02,5	8
,6	08 6	02,8	9
,9	09,5	03,1	10
,2	10,5	03,4	11
,5	11,4	03,7	12
,8	12,4	04,0	13
,1	13,3	04,3	14
,4	14,3	04,6	15
,7	15,2	04,9	16
,0	16,	05,2	17
,3	17,1	05,6	18
,5	18,1	05,9	19
,8	19,0	06,2	20
,1	20,0	06,5	21
,4	20,9	06,8	22
,7	21,9	07,1	23
,0	22,8	07,4	24
,3	23,8	07,7	25
,6	24,7	08,0	26
,9	25,7	08,3	27
,2	26,6	08,6	28
,5	27,6	09,0	29
,8	28,5	09,3	30
,1	29,5	09,6	31
,3	30,4	10,0	32
,6	31,4	10,2	33
,9	32,3	10,5	34
,2	33,3	10,8	35
,5	34,2	11,1	36
,8	35,2	11,4	37
,1	36,1	11,7	38
,4	37,1	12,0	39
,7	38,0	12,4	40
,0	39,0	12,7	41
,3	39,9	13,0	42
,6	40,9	13,3	43
,9	41,8	13,6	44
,1	42,8	13,9	45
,4	43,7	14,2	46
,7	44,7	14,5	47
,0	45,6	14,8	48
,3	46,6	15,1	49
,6	47,5	15,4	50
at.	Dep	Lat.	Dist.
3 Deg	72 Deg.		

Dist.	1¼ Point		15 Deg.		16 Deg.		1½ Point		17 Deg.		18 Deg.		Dist.
	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	
51	49,5	12,4	49,3	13,2	49,0	14,0	48,8	14,8	48,8	14,9	48,5	15,8	51
52	50,4	12,6	50,2	13,5	49,0	14,3	49,7	15,1	49,7	15,2	49,4	16,1	52
53	51,4	12,9	51,2	13,7	50,9	14,6	50,7	15,3	50,7	15,5	50,4	16,4	53
54	52,4	13,1	52,2	14,0	51,9	14,9	51,7	15,7	51,6	15,8	51,3	16,7	54
55	53,3	13,4	53,1	14,2	52,9	15,2	52,6	16,0	52,6	16,1	52,3	17,0	55
56	54,3	13,6	54,1	14,5	53,8	15,4	53,6	16,2	53,6	16,4	53,3	17,3	56
57	55,3	13,8	55,1	14,8	54,8	15,7	54,5	16,5	54,5	16,7	54,2	17,6	57
58	56,3	14,1	56,0	15,0	55,7	16,0	55,5	16,8	55,5	17,0	55,2	17,9	58
59	57,3	14,3	57,0	15,3	56,7	16,3	56,5	17,1	56,5	17,2	56,1	18,2	59
60	58,2	14,6	58,0	15,5	57,7	16,5	57,4	17,4	57,4	17,5	57,1	18,5	60
61	59,2	14,8	58,9	15,8	58,6	16,8	58,4	17,7	58,4	17,8	58,0	18,8	61
62	60,1	15,1	59,9	16,1	59,6	17,1	59,3	18,0	59,3	18,1	59,0	19,2	62
63	61,1	15,3	60,8	16,3	60,5	17,4	60,3	18,3	60,2	18,4	59,9	19,5	63
64	62,1	15,5	61,8	16,6	61,5	17,6	61,2	18,6	61,2	18,7	60,9	19,8	64
65	63,0	15,8	62,8	16,8	62,5	17,9	62,2	18,9	62,2	19,0	61,8	20,1	65
66	64,0	16,0	63,7	17,1	63,4	18,2	63,2	19,2	63,1	19,3	62,8	20,4	66
67	65,0	16,3	64,7	17,4	64,4	18,5	64,1	19,4	64,1	19,6	63,7	20,7	67
68	66,0	16,5	65,7	17,6	65,4	18,7	65,1	19,7	65,0	19,9	64,7	21,0	68
69	66,9	16,8	66,6	17,9	66,3	19,0	66,0	20,0	66,0	20,2	65,6	21,3	69
70	67,7	17,0	67,6	18,1	67,3	19,3	67,0	20,3	66,9	20,5	66,6	21,6	70
71	68,9	17,2	68,6	18,3	68,2	19,6	67,9	20,6	67,9	20,8	67,5	21,9	71
72	69,8	17,5	69,6	18,6	69,2	19,8	68,9	20,9	68,8	21,0	68,5	22,2	72
73	70,8	17,7	70,5	18,9	70,2	20,1	69,8	21,2	69,8	21,3	69,4	22,6	73
74	71,8	18,0	71,5	19,1	71,1	20,4	70,8	21,5	70,8	21,6	70,4	22,9	74
75	72,7	18,2	72,4	19,4	72,1	20,7	71,8	21,8	71,7	21,9	71,3	23,2	75
76	73,7	18,5	73,4	19,7	73,0	20,9	72,7	22,1	72,7	22,2	72,3	23,5	76
77	74,7	18,7	74,4	19,9	74,0	21,2	73,7	22,3	73,6	22,5	73,2	23,8	77
78	75,7	18,9	75,3	20,2	75,0	21,5	74,6	22,6	74,6	22,8	74,2	24,1	78
79	76,6	19,2	76,3	20,4	75,9	21,8	75,6	22,9	75,5	23,1	75,1	24,4	79
80	77,6	19,4	77,3	20,7	76,9	22,0	76,6	23,2	76,5	23,4	76,1	24,7	80
81	78,6	19,7	78,2	21,0	77,9	22,3	77,5	23,5	77,5	23,7	77,0	25,0	81
82	79,5	19,9	79,2	21,2	78,8	22,6	78,5	23,8	78,4	24,0	78,0	25,3	82
83	80,5	20,3	80,2	21,5	79,8	22,9	79,4	24,1	79,4	24,3	78,9	25,6	83
84	81,5	20,4	81,1	21,7	80,8	23,1	80,4	24,4	80,3	24,5	79,9	26,0	84
85	82,4	20,7	82,1	22,0	81,7	23,4	81,3	24,7	81,3	24,8	80,8	26,3	85
86	83,4	20,9	83,1	22,3	82,7	23,7	82,3	25,0	82,2	25,1	81,8	26,6	86
87	84,4	21,1	84,0	22,5	83,6	24,0	83,3	25,2	83,2	25,4	82,7	26,9	87
88	85,4	21,4	85,0	22,8	84,6	24,2	84,2	25,5	84,1	25,7	83,7	27,2	88
89	86,3	21,6	86,0	23,0	85,6	24,5	85,2	25,8	85,1	26,0	84,6	27,5	89
90	87,3	21,9	86,9	23,3	86,5	24,8	86,1	26,1	86,1	26,3	85,6	27,8	90
91	88,3	22,1	87,9	23,5	87,5	25,1	87,1	26,4	87,0	26,6	86,5	28,1	91
92	89,2	22,4	88,9	23,8	88,4	25,3	88,0	26,7	88,0	26,9	87,5	28,4	92
93	90,2	22,6	89,8	24,1	89,4	25,5	89,0	27,0	88,9	27,2	88,4	28,7	93
94	91,2	22,8	90,8	24,3	90,4	25,9	90,0	27,3	89,9	27,5	89,4	29,0	94
95	92,1	23,1	91,8	24,6	91,3	26,2	90,9	27,6	90,8	27,8	90,3	29,3	95
96	93,1	23,3	92,7	24,8	92,3	26,4	91,9	27,9	91,8	28,1	91,3	29,7	96
97	94,1	23,6	93,7	25,1	93,2	26,7	92,8	28,2	92,8	28,4	92,3	30,0	97
98	95,1	23,8	94,7	25,4	94,2	27,0	93,8	28,4	93,7	28,6	93,2	30,3	98
99	96,0	24,1	95,6	25,6	95,2	27,3	94,7	28,7	94,7	28,9	94,2	30,6	99
100	97,0	24,3	96,6	25,9	96,1	27,6	95,7	29,0	95,6	29,2	95,1	30,9	100
Dist.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dist.
	6¼ Point		75 Deg.		74 Deg.		6½ Point		73 Deg.		72 Deg.		

Dist.	19 Deg.		1¾ Point.		20 Deg.		21 Deg.		22 Deg.		2 Points.		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	48.2	16.6	48.0	17.2	47.9	17.4	47.6	18.3	47.3	19.1	47.1	19.5	51
52	49.2	16.9	49.0	17.5	48.9	17.8	48.5	18.6	48.2	19.5	48.0	19.9	52
53	50.1	17.3	49.9	17.9	49.8	18.1	49.5	19.0	49.1	19.9	49.0	20.3	53
54	51.1	17.6	50.8	18.2	50.7	18.5	50.4	19.4	50.1	20.2	49.9	20.7	54
55	52.0	17.9	51.8	18.5	51.7	18.8	51.3	19.7	51.0	20.6	50.8	21.0	55
56	52.9	18.2	52.7	18.9	52.6	19.2	52.3	20.1	51.9	21.0	51.7	21.4	56
57	53.9	18.6	53.7	19.2	53.6	19.5	53.2	20.4	52.8	21.4	52.7	21.8	57
58	54.8	18.9	54.6	19.5	54.5	19.8	54.1	20.8	53.8	21.7	53.6	22.2	58
59	55.8	19.2	55.5	19.9	55.4	20.2	55.1	21.1	54.7	22.1	54.5	22.6	59
60	56.7	19.5	56.5	20.2	56.4	20.5	56.0	21.5	55.6	22.5	55.4	23.0	60
61	57.7	19.9	57.4	20.6	57.3	20.9	56.9	21.9	56.6	22.9	56.4	23.3	61
62	58.6	20.2	58.4	20.9	58.3	21.2	57.9	22.2	57.5	23.2	57.3	23.7	62
63	59.6	20.5	59.3	21.2	59.2	21.5	58.8	22.6	58.4	23.6	58.2	24.1	63
64	60.5	20.8	60.3	21.6	60.1	21.9	59.7	22.9	59.3	24.0	59.1	24.5	64
65	61.5	21.2	61.2	21.9	61.1	22.2	60.7	23.3	60.3	24.3	60.1	24.9	65
66	62.4	21.5	62.1	22.2	62.0	22.6	61.6	23.7	61.2	24.7	61.0	25.3	66
67	63.3	21.8	63.1	22.6	63.0	22.9	62.5	24.0	62.1	25.1	61.9	25.6	67
68	64.3	22.1	64.0	22.9	63.9	23.3	63.5	24.4	63.0	25.5	62.8	26.0	68
69	65.2	22.5	65.0	23.2	64.8	23.6	64.4	24.7	64.0	25.8	63.7	26.4	69
70	66.2	22.8	65.9	23.6	65.8	23.9	65.3	25.1	64.9	26.2	64.7	26.8	70
71	67.1	23.1	66.8	23.9	66.7	24.3	66.3	25.4	65.8	26.6	65.6	27.2	71
72	68.1	23.4	67.8	24.3	67.7	24.6	67.2	25.8	66.8	27.0	66.5	27.6	72
73	69.0	23.8	68.7	24.6	68.6	25.0	68.2	26.2	67.7	27.3	67.4	27.9	73
74	70.0	24.1	69.7	24.9	69.5	25.3	69.1	26.5	68.6	27.7	68.4	28.3	74
75	70.9	24.4	70.6	25.3	70.5	25.6	70.0	26.9	69.5	28.1	69.3	28.7	75
76	71.9	24.7	71.6	25.6	71.4	26.0	71.0	27.2	70.5	28.5	70.2	29.1	76
77	72.8	25.1	72.5	25.9	72.4	26.3	71.9	27.6	71.4	28.8	71.1	29.5	77
78	73.7	25.4	73.4	26.3	73.3	26.7	72.8	28.0	72.3	29.2	72.1	29.8	78
79	74.7	25.7	74.4	26.6	74.2	27.0	73.7	28.3	73.2	29.6	73.0	30.2	79
80	75.6	26.0	75.3	27.0	75.2	27.4	74.7	28.7	74.2	30.0	73.9	30.6	80
81	76.6	26.4	76.3	27.3	76.1	27.7	75.6	29.0	75.1	30.3	74.8	31.0	81
82	77.5	26.7	77.2	27.6	77.1	28.0	76.5	29.4	76.0	30.7	75.8	31.4	82
83	78.5	27.0	78.1	28.0	78.0	28.4	77.5	29.7	77.0	31.1	76.7	31.8	83
84	79.4	27.3	79.1	28.3	78.9	28.7	78.4	30.1	77.9	31.5	77.6	32.1	84
85	80.4	27.7	80.0	28.6	79.9	29.1	79.4	30.5	78.8	31.8	78.5	32.5	85
86	81.3	28.0	81.0	29.0	80.8	29.4	80.3	30.8	79.7	32.2	79.5	32.9	86
87	82.3	28.3	81.9	29.3	81.8	29.8	81.2	31.2	80.7	32.6	80.4	33.3	87
88	83.2	28.6	82.9	29.6	82.7	30.1	82.2	31.5	81.6	33.0	81.3	33.7	88
89	84.2	29.0	83.8	30.0	83.6	30.4	83.1	31.9	82.5	33.3	82.2	34.1	89
90	85.1	29.3	84.7	30.3	84.6	30.8	84.0	32.3	83.4	33.7	83.1	34.4	90
91	86.0	29.6	85.7	30.7	85.5	31.1	85.0	32.6	84.4	34.1	84.1	34.8	91
92	87.0	30.0	86.6	31.0	86.5	31.5	85.9	33.0	85.3	34.5	85.0	35.2	92
93	87.9	30.3	87.6	31.3	87.4	31.8	86.8	33.3	86.2	34.8	85.9	35.6	93
94	88.9	30.6	88.5	31.7	88.3	32.1	87.8	33.7	87.2	35.2	86.8	36.0	94
95	89.8	30.9	89.4	32.0	89.3	32.5	88.7	34.0	88.1	35.6	87.8	36.4	95
96	90.8	31.3	90.4	32.3	90.2	32.8	89.6	34.4	89.0	36.0	88.7	36.7	96
97	91.7	31.6	91.3	32.7	91.1	33.2	90.6	34.8	89.9	36.3	89.6	37.1	97
98	92.7	31.9	92.3	33.0	92.1	33.5	91.5	35.1	90.9	36.7	90.5	37.5	98
99	93.6	32.2	93.2	33.4	93.0	33.9	92.4	35.5	91.8	37.1	91.5	37.9	99
100	94.6	32.6	94.2	33.7	94.0	34.2	93.4	35.8	92.7	37.5	92.4	38.3	100
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	71 Deg.		6¼ Points.		70 Deg.		69 Deg.		68 Deg.		6 Points.		

Dist.	23 Deg.		24 Deg.		25 Deg.		2 ¼ Point		26 Deg.		27 Deg.		Dist.
	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	
1	00.9	00.4	00.9	00.4	00.9	00.4	00.9	00.4	00.9	00.4	00.9	00.4	1
2	01.8	00.8	01.8	00.8	01.8	00.8	01.8	00.9	01.8	00.9	01.8	00.9	2
3	02.8	01.2	02.7	01.2	02.7	01.3	02.7	01.3	02.7	01.3	02.7	01.4	3
4	03.7	01.6	03.6	01.6	03.6	01.7	03.6	01.7	03.6	01.7	03.6	01.[illegible]	4
5	04.6	01.9	04.6	02.0	04.5	02.1	04.5	02.1	04.5	02.2	04.5	02.3	5
6	05.5	02.3	05.5	02.4	05.4	02.5	05.4	02.6	05.4	02.6	05.3	02.7	6
7	06.4	02.7	06.4	02.8	06.3	03.0	06.3	03.0	06.3	03.1	06.2	03.2	7
8	07.4	03.1	07.3	03.2	07.2	03.4	07.2	03.4	07.2	03.5	07.1	03.6	8
9	08.3	03.5	08.2	03.7	08.2	03.8	08.1	03.8	08.1	03.9	08.0	04.1	9
10	09.2	03.9	09.1	04.1	09.1	04.2	09.0	04.3	09.0	04.4	08.9	04.5	10
11	10.1	04.3	10.0	04.5	10.0	04.6	09.9	04.7	09.9	04.8	09.8	05.0	11
12	11.0	04.7	11.0	04.9	10.9	05.1	10.8	05.1	10.8	05.3	10.7	05.4	12
13	12.0	05.1	11.9	05.3	11.8	05.5	11.7	05.6	11.7	05.7	11.6	05.9	13
14	12.9	05.5	12.8	05.7	12.7	05.9	12.7	05.9	12.6	06.1	12.5	06.4	14
15	13.8	05.9	13.7	06.1	13.6	06.3	13.6	06.4	13.5	06.6	13.4	06.8	15
16	14.7	06.2	14.6	06.5	14.5	06.8	14.5	06.6	14.4	07.0	14.3	07.3	16
17	15.6	06.6	15.5	06.9	15.4	07.2	15.4	07.3	15.3	07.4	15.1	07.7	17
18	16.6	07.0	16.4	07.3	16.3	07.6	16.3	07.7	16.2	07.9	16.0	08.2	18
19	17.5	07.4	17.4	07.7	17.2	08.0	17.2	08.1	17.1	08.3	16.9	08.6	19
20	18.4	07.8	18.3	08.1	18.1	08.4	18.1	08.5	18.6	08.8	17.8	09.1	20
21	19.3	08.2	19.2	08.5	19.0	08.9	19.0	09.0	18.9	09.2	18.7	09.5	21
22	20.2	08.6	20.1	08.9	19.9	09.3	19.9	09.4	19.8	09.9	19.6	10.0	22
23	21.2	09.0	21.0	09.3	20.8	09.7	20.8	09.8	20.7	10.1	20.5	10.4	23
24	22.1	09.4	21.9	09.8	21.7	10.1	21.7	10.3	21.6	10.5	21.4	10.9	24
25	23.0	09.8	22.8	10.2	22.7	10.6	22.6	10.7	22.5	11.0	22.3	11.3	25
26	23.9	10.[illegible]	23.7	10.6	23.6	11.0	23.5	11.1	23.4	11.4	23.2	11.8	26
27	24.8	10.5	24.7	11.0	24.5	11.4	24.4	11.5	24.3	11.8	24.1	12.8	27
28	25.8	10.9	25.6	11.4	25.4	11.8	25.3	12.0	25.2	12.3	24.9	12.7	28
29	26.7	11.3	26.5	11.8	26.3	12.3	26.2	12.4	26.1	12.7	25.8	13.2	29
30	27.6	11.7	27.4	12.2	27.2	12.7	27.1	12.8	27.0	13.1	26.7	13.6	30
31	28.5	12.1	28.3	12.6	28.1	13.1	28.0	13.3	27.9	13.6	27.6	14.1	31
32	29.5	12.5	29.2	13.0	29.0	13.5	28.9	13.7	28.8	14.0	28.5	14.5	32
33	30.4	12.9	30.1	13.4	29.9	13.9	29.8	14.1	29.6	14.4	29.4	15.0	33
34	31.3	13.3	31.1	13.8	30.8	14.4	30.7	14.5	30.6	14.9	30.3	15.4	34
35	32.2	13.7	32.0	14.2	31.7	14.8	31.6	15.0	31.5	15.3	31.2	15.9	35
36	33.1	14.1	32.9	14.6	32.6	15.[illegible]	32.5	15.4	32.4	15.8	32.1	16.3	36
37	34.1	14.4	33.8	15.0	33.5	15.6	33.4	15.8	33.[illegible]	16.2	33.0	16.8	37
38	35.0	14.8	34.7	15.4	34.4	16.0	34.3	16.2	34.0	16.6	33.9	17.2	38
39	35.9	15.2	35.6	15.9	35.3	16.5	35.3	16.7	35.1	17.1	34.7	17.7	39
40	36.8	15.6	36.5	16.3	36.2	16.9	36.2	17.1	35.9	17.5	35.6	18.2	40
41	37.7	16.0	37.5	16.7	37.2	17.3	37.1	17.5	36.8	18.0	36.5	18.6	41
42	38.7	16.4	38.4	17.1	38.1	17.7	38.0	18.0	37.[illegible]	18.4	37.4	19.1	42
43	39.6	16.8	39.3	17.5	39.0	18.2	38.9	18.4	38.6	18.[illegible]	38.3	19.5	43
44	40.5	17.2	40.2	17.9	39.9	18.6	39.9	18.8	39.5	19.3	39.2	20.0	44
45	41.4	17.6	41.1	18.3	40.8	19.0	40.7	19.2	40.4	19.7	40.1	20.4	45
46	42.3	18.0	42.0	18.7	41.7	19.4	41.6	19.7	41.[illegible]	20.2	41.0	20.9	46
47	43.3	18.4	42.9	19.1	42.6	19.9	42.5	20.1	42.2	20.6	41.9	21.3	47
48	44.2	18.8	43.8	19.5	43.5	20.3	43.4	20.5	43.1	21.0	42.8	21.8	48
49	45.1	19.2	44.8	19.9	44.4	20.7	44.3	20.9	44.0	21.5	43.7	2[illegible].2	49
50	46.0	19.5	45.7	20.3	45.3	21.1	45.2	21.4	44.9	21.9	44.5	22.7	50
Dist.	Dep	Lat.	Dep.	Lat.	Dep	Lat	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dist.
	67 Deg.		66 Deg.		65 Deg.		5 ¾ Point		64 Deg		63 Deg		

Dist.	23 Deg.		24 Deg.		25 Deg.		2¼ Point.		26 Deg.		27 Deg.		Dist.
	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	
51	46.9	19.9	46.6	20.7	46.2	21.5	46.1	21.2	45.8	22.3	45.4	23.2	51
52	47.9	20.3	47.5	21.1	47.1	22.0	47.9	22.2	46.7	22.8	46.3	23.5	52
53	48.8	20.7	48.4	21.5	48.0	22.4	47.9	22.7	47.6	23.2	47.2	24.1	53
54	49.7	21.1	49.3	22.0	48.9	22.8	48.8	23.1	48.5	23.7	48.1	24.5	54
55	50.6	21.5	50.2	22.4	49.8	23.2	49.7	23.5	49.4	24.1	49.0	25.0	55
56	51.5	21.9	51.2	22.8	50.7	23.7	50.6	23.9	50.4	24.5	49.9	25.4	56
57	52.5	22.3	52.1	23.2	51.7	24.1	51.5	24.4	51.2	25.0	50.8	25.9	57
58	53.4	22.7	53.0	23.6	52.6	24.5	52.4	24.8	52.1	25.4	51.7	26.3	58
59	54.3	23.0	53.9	24.0	53.5	24.9	53.3	25.2	53.0	25.9	52.6	26.8	59
60	55.2	23.4	54.8	24.4	54.4	25.4	54.2	25.6	53.9	26.3	53.5	27.2	60
61	56.1	23.8	55.7	24.8	55.3	25.8	55.1	26.1	54.8	26.7	54.4	27.7	61
62	57.1	24.2	56.6	25.2	56.2	26.2	56.0	26.5	55.7	27.2	55.2	28.1	62
63	58.0	24.6	57.5	25.6	57.1	26.6	56.9	26.9	56.6	27.6	56.1	28.6	63
64	58.9	25.0	58.5	26.0	58.0	27.0	57.9	27.4	57.5	28.0	57.0	29.1	64
65	59.8	25.4	59.4	26.4	58.9	27.5	58.8	27.8	58.4	28.5	57.9	29.5	65
66	60.7	25.8	60.3	26.8	59.8	27.9	59.7	28.2	59.3	28.9	58.8	30.0	66
67	61.7	26.2	61.2	27.2	60.7	28.3	60.6	28.6	60.2	29.4	59.7	30.4	67
68	62.6	26.6	62.1	27.7	61.6	28.7	61.5	29.1	61.1	29.8	60.6	30.9	68
69	63.5	27.0	63.0	28.1	62.5	29.2	62.4	29.5	62.0	30.2	61.5	31.3	69
70	64.4	27.3	63.9	28.5	63.4	29.6	63.3	29.9	62.9	30.7	62.4	31.8	70
71	65.4	27.7	64.9	28.9	64.3	30.0	64.2	30.4	63.8	31.1	63.3	32.2	71
72	66.3	28.1	65.8	29.3	65.2	30.4	65.1	30.8	64.7	31.6	64.2	32.7	72
73	67.2	28.5	66.7	29.7	66.2	30.8	66.0	31.2	65.6	32.0	65.0	33.1	73
74	68.1	28.9	67.6	30.1	67.1	31.3	66.9	31.6	66.5	32.4	65.9	33.6	74
75	69.0	29.3	68.5	30.5	68.0	31.7	67.8	32.1	67.4	32.9	66.8	34.1	75
76	70.0	29.7	69.4	30.9	68.9	32.1	68.7	32.5	68.3	33.3	67.7	34.5	76
77	70.9	30.1	70.3	31.3	69.8	32.5	69.6	32.9	69.2	33.7	68.6	35.0	77
78	71.8	30.5	71.2	31.7	70.7	33.0	70.5	33.4	70.1	34.2	69.5	35.4	78
79	72.7	30.9	72.2	32.1	71.6	33.5	71.4	33.8	71.0	34.6	70.4	35.9	79
80	73.6	31.3	73.1	32.5	72.5	33.8	72.3	34.2	71.9	35.1	71.3	36.3	80
81	74.6	31.6	74.0	32.9	73.4	34.2	73.2	34.6	72.8	35.5	72.2	36.8	81
82	75.5	32.0	74.9	33.3	74.3	34.7	74.1	35.1	73.7	35.9	73.1	37.2	82
83	76.4	32.4	75.8	33.8	75.2	35.1	75.0	35.5	74.6	36.4	74.0	37.7	83
84	77.3	32.8	76.7	34.2	76.1	35.5	75.9	35.9	75.5	36.8	74.8	38.1	84
85	78.2	33.2	77.6	34.6	77.0	35.9	76.8	36.3	76.4	37.3	75.7	38.6	85
86	79.2	33.6	78.6	35.0	77.9	36.3	77.7	36.8	77.3	37.7	76.6	39.0	86
87	80.1	34.0	79.5	35.4	78.8	36.8	78.6	37.2	78.2	38.1	77.5	39.5	87
88	81.0	34.4	80.4	35.8	79.7	37.2	79.5	37.6	79.1	38.6	78.4	40.0	88
89	81.9	34.8	81.3	36.2	80.7	37.6	80.5	38.1	80.0	39.0	79.3	40.4	89
90	82.8	35.2	82.2	36.6	81.6	38.0	81.4	38.5	80.9	39.4	80.2	40.9	90
91	83.7	35.6	83.1	37.0	82.5	38.5	82.3	38.9	81.8	39.8	81.1	41.1	91
92	84.7	35.9	84.0	37.4	83.4	38.9	83.2	39.3	82.7	40.3	82.0	41.8	92
93	85.6	36.3	85.0	37.8	84.3	39.3	84.1	39.8	83.6	40.8	82.9	42.2	93
94	86.4	36.7	85.9	38.2	85.2	39.7	85.0	40.2	84.5	41.2	83.8	42.7	94
95	87.4	37.1	86.8	38.6	86.1	40.1	85.9	40.6	85.4	41.6	84.6	43.1	95
96	88.4	37.5	87.7	39.0	87.0	40.6	86.8	41.0	86.3	42.1	85.5	43.6	96
97	89.3	37.9	88.6	39.4	87.9	41.0	87.7	41.5	87.2	42.5	86.4	44.0	97
98	90.2	38.3	89.5	39.9	88.8	41.4	88.6	41.9	88.1	43.0	87.3	44.5	98
99	91.1	38.7	90.4	40.3	89.7	41.8	89.5	42.3	89.0	43.4	88.2	44.9	99
100	92.0	39.1	91.4	40.7	90.6	42.3	90.4	42.7	89.9	43.8	89.1	45.4	100
Dist.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dist.
	67 Deg.		66 Deg.		65 Deg.		5¾ Point.		64 Deg.		63 Deg.		

Dist.	28 Deg. Lat.	28 Deg. Dep	2½ Point Lat.	2½ Point Dep	29 Deg. Lat.	29 Deg. Dep	30 Deg. Lat.	30 Deg. Dep	2¾ Point. Lat.	2¾ Point. Dep	31 Deg. Lat.	31 Deg. Dep	Dist.
51	45.0	23.9	45.0	24.0	44.6	24.7	44.2	25.5	43.7	26.2	43.7	26.3	51
52	45.9	24.4	45.9	24.5	45.5	25.2	45.0	26.0	44.6	26.7	14.6	26.8	52
53	46.8	24.9	46.7	25.0	46.3	25.7	45.9	26.5	45.5	27.2	45.4	27.3	53
54	47.7	25.3	47.6	25.5	47.2	26.2	46.8	27.0	46.3	27.8	46.3	27.8	54
55	48.6	25.8	48.5	25.9	48.1	26.7	47.6	27.5	47.2	28.3	47.1	28.3	55
56	49.4	26.3	49.4	26.4	49.0	27.1	48.5	28.0	48.0	28.8	48.0	28.8	56
57	50.3	26.8	50.3	26.9	49.8	27.6	49.4	28.5	48.9	29.3	48.9	29.4	57
58	51.2	27.2	51.2	27.3	50.7	28.1	50.2	29.0	49.7	29.8	49.7	29.9	58
59	52.1	27.7	52.0	27.8	51.6	28.6	51.1	29.5	50.6	30.3	50.6	30.4	59
60	53.0	28.2	52.9	28.3	52.5	29.1	52.0	30.0	51.5	30.8	51.4	30 9	60
61	53.9	28.6	53.8	28.7	53.3	29.6	52.8	30.5	52.3	31.4	52.3	31.4	61
62	54.7	29.1	54.7	29.2	54.2	90.1	53.7	31.0	53.2	31.9	53.1	31.9	62
63	55.6	29.6	55.6	29.7	55.1	30.5	54.6	31.5	54.0	32.4	54.0	32.4	63
64	56.5	30.0	56.4	30.2	56.0	31.0	55.4	32.0	54.9	32.9	54.9	33.0	64
65	57.4	30.5	57.3	30.5	56.8	31.5	56.3	32.5	55.7	33.4	55.7	33.5	65
66	58.4	31.0	58.2	31.1	57.7	32.0	57.2	33.0	56.6	33.9	56.6	34.0	66
67	59.2	31.4	59.1	31.6	58.6	32.5	58.0	33.5	57.5	34.4	57.4	34.5	67
68	60.0	31.9	60.0	32.0	59.5	33.0	58.9	34.0	58.3	35.0	58.3	35.0	68
69	60.9	32.4	60.8	32.5	60.3	33.4	59.7	34.5	59.2	35.5	59.1	35.5	69
70	61.8	32.9	61.7	33.0	61.2	33.9	60.6	35.0	60.0	36.0	60.0	36.0	70
71	62.7	33.3	62.6	33.5	62.1	34.4	61.5	35.5	60.9	36.5	60.9	36.6	71
72	63.6	33.8	63.5	33.9	63.0	34.9	62.3	36.0	61.8	37.0	61.7	37.1	72
73	64.4	34.3	64.4	34.4	63.8	35.4	63.2	36.5	62.6	37.5	62.6	37.6	73
74	65.3	34.7	65.3	34.9	64.7	35.9	64.1	37.0	63.5	38.0	63.4	38.1	74
75	66.2	35.2	66.1	35.4	65.6	36.4	64.9	37.5	64.3	38.6	64.3	38.6	75
76	67.1	35.7	67.0	35.8	66.5	36.8	65.8	38.0	65.2	39.1	65.1	39.1	76
77	68.0	36.1	67.9	36.3	67.3	37.3	66.7	38.5	66.0	39.6	66.0	39.7	77
78	68.9	36.6	68.8	36.8	68.2	37.8	67.5	39.0	66.9	40.1	66.9	40.2	78
79	69.7	37.1	69.7	37.2	69.1	38.3	68 4	39.5	67.8	40.6	67.7	40.7	79
80	70.6	37.6	70.5	37.7	70.0	38.8	69.3	40.0	68.6	41.1	68.6	41.2	80
81	71.5	38.0	71.4	38.2	70.8	39.3	70.1	40.5	69.3	41.6	69.4	41.7	81
82	72.4	38.5	72.3	38.6	71.7	39.7	70.9	41.0	70.3	42.2	70.3	42.2	82
83	73.3	39.0	73.2	39.1	72.6	40.2	71.9	41.5	71.2	42.7	71.1	42.7	83
84	74.2	39.4	74.1	39.6	73.5	40.7	72.7	42.0	72.1	43.2	72.0	43.3	84
85	75.0	39.9	75.0	40.1	74.3	41.2	73.6	42.5	72.9	43.7	72.9	43.8	85
86	75.9	40.4	75.8	40.5	75.2	41.7	74.5	43.0	73.8	44.2	73.7	44.3	86
87	76.8	40.8	76.7	41.0	76.1	42.2	75.3	43.5	74.6	44.7	74.6	44.8	87
88	77.7	41.3	77.6	41.5	77.0	42.7	76.2	44.0	75.5	45.2	75.4	45.3	88
89	78.6	41.8	78.5	41.9	77.8	43.1	77.1	44.5	76.3	45.8	76.3	45.8	89
90	79.5	42.2	79.4	42.4	78.7	43.6	77.9	45.0	77.2	46.3	77.1	46.3	90
91	80.3	42.7	80.2	42.9	79.6	44.1	78.8	45.5	78.1	46.8	78.0	46.9	91
92	81.2	43.2	81.1	43.4	80.5	44.6	79.7	46.0	78.9	47.3	78.9	47.4	92
93	82.1	43.6	82.0	43.8	81.3	45.1	80.5	46.5	79.8	47.8	79.7	47.9	93
94	83.0	44.1	82.9	44.3	82.2	45.6	81.4	47.0	80.6	48.3	80.6	48.4	94
95	83.9	44.6	83.8	44.8	83.1	46.1	82.3	47.5	81.5	48.8	81.4	48.9	95
96	84.8	45.1	84.7	45.2	84.0	46.5	83.1	48.0	82.3	49.3	82.3	49.4	96
97	85.6	45.5	85.5	45.7	84.8	47.0	84.0	48.5	83.2	49.9	83.1	50.0	97
98	86.5	46.0	86.4	46.2	85.7	47.5	84.9	49.0	84.1	50.4	84.0	50.5	98
99	87.4	46.5	87.3	46.7	86.6	48.0	85.7	49.5	84.9	50.9	84.9	51.0	99
100	88.3	46.9	88.2	47.1	87.5	48.5	86.6	50.0	85.8	51.4	85.7	51.5	100
Dist.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat	Dep	Lat.	Dist.
	62 Deg.		5½ Point		61 Deg.		60 Deg.		5¼ Point.		59 Deg.		

Dist.	32 Deg. Lat.	32 Deg. Dep	33 Deg. Lat.	33 Deg. Dep	3 Points Lat.	3 Points Dep	34 Deg. Lat.	34 Deg. Lat.	35 Deg. Lat.	35 Deg. Dep.	36 Deg. Lat.	36 Deg. Dep	Dist.
1	00.8	00.5	00.8	00.5	00.8	00.6	00.8	00.6	00.8	00.6	00.8	00.6	1
2	01.7	01.1	01.7	01.1	01.7	01.1	01.7	01.1	01.6	01.1	01.6	01.2	2
3	02.5	01.6	02.5	01.6	02.5	01.7	02.5	01.7	02.5	01.7	02.4	01.8	3
4	03.4	02.1	03.4	02.2	03.3	02.2	03.3	02.2	03.3	02.3	03.2	02.3	4
5	04.2	02.6	04.2	02.7	04.2	02.8	04.1	02.8	04.1	02.9	04.0	02.9	5
6	05.1	03.2	05.0	03.3	05.0	03.3	05.0	03.4	04.9	03.4	04.8	03.5	6
7	05.9	03.7	05.9	03.8	05.8	03.9	05.8	03.9	05.7	04.0	05.7	04.1	7
8	06.8	04.2	06.7	04.4	06.6	04.4	06.6	04.5	06.5	04.6	06.5	04.7	8
9	07.6	04.8	07.5	04.9	07.5	05.0	07.5	05.0	07.4	05.2	07.3	05.3	9
10	08.5	05.3	08.4	05.4	08.3	05.6	08.3	05.6	08.2	05.7	08.1	05.9	10
11	09.3	05.8	09.2	06.0	09.1	06.1	09.1	06.1	09.0	06.3	08.9	06.5	11
12	10.2	06.4	10.1	06.5	10.0	06.7	09.9	06.7	09.8	06.9	09.7	07.0	12
13	11.0	06.9	10.9	07.1	10.8	07.2	10.8	07.3	10.6	07.5	10.5	07.6	13
14	11.9	07.4	11.7	07.6	11.6	07.8	11.6	[illegible]	11.5	08.0	11.3	08.2	14
15	12.7	07.9	12.6	08.2	12.5	08.3	12.4	08.4	12.3	08.6	12.1	08.8	15
16	13.6	08.5	13.4	08.7	13.3	08.9	13.3	08.9	13.1	09.2	12.9	09.4	16
17	14.4	09.0	14.3	09.3	14.1	09.4	14.1	09.5	13.9	09.8	13.7	10.0	17
18	15.3	09.5	15.1	09.8	15.0	10.0	14.9	10.1	14.7	10.3	14.6	10.6	18
19	16.1	10.1	15.9	10.3	15.8	10.6	15.7	10.6	15.6	10.9	15.4	11.2	19
20	17.0	10.6	16.8	10.9	16.6	11.1	16.6	11.2	16.4	11.5	16.2	11.8	20
21	17.8	11.1	17.6	11.4	17.5	11.7	17.4	11.7	17.2	12.0	17.0	12.3	21
22	18.6	11.7	18.5	12.0	18.3	12.2	18.2	12.3	18.0	12.6	17.8	12.9	22
23	19.5	12.2	19.3	12.5	19.1	12.8	19.0	12.8	18.8	13.2	18.6	13.5	23
24	20.3	12.7	20.1	13.1	20.0	13.3	19.9	13.4	19.7	13.8	19.4	14.1	24
25	21.2	13.2	21.0	13.6	20.7	13.9	20.7	14.0	20.5	14.3	20.1	14.7	25
26	22.0	13.8	21.8	14.2	21.6	14.4	21.5	14.5	21.3	14.9	21.0	15.3	26
27	22.9	14.3	22.6	14.7	22.4	15.0	22.4	15.1	22.1	15.5	21.8	15.9	27
28	23.7	14.8	23.5	15.2	23.3	15.5	23.2	15.6	22.9	16.1	22.6	16.5	28
29	24.6	15.4	24.3	15.8	24.1	16.1	24.0	16.2	23.8	16.6	23.5	17.0	29
30	25.4	15.9	25.2	16.3	24.9	16.7	24.9	16.8	24.6	17.2	24.3	17.6	30
31	26.3	16.4	26.0	16.9	25.8	17.2	25.7	17.3	25.4	17.8	25.1	18.2	31
32	27.1	17.0	26.8	17.4	26.6	17.8	26.5	17.9	26.2	18.3	25.9	18.8	32
33	28.0	17.5	27.7	18.0	27.4	18.3	27.4	18.4	27.0	18.9	26.7	19.4	33
34	28.8	18.0	28.5	18.5	28.3	18.9	28.2	19.0	27.9	19.5	27.5	20.0	34
35	29.7	18.5	29.4	19.1	29.1	19.4	29.0	16.6	28.7	20.1	28.3	20.6	35
36	30.5	19.1	30.2	19.6	29.9	20.0	29.8	20.1	29.5	20.6	29.1	21.2	36
37	31.4	19.6	31.0	20.1	30.8	20.6	30.7	20.7	30.3	21.2	29.9	21.7	37
38	32.2	20.1	31.9	20.7	31.6	21.1	31.5	21.2	31.1	21.8	30.7	22.3	38
39	33.1	20.7	32.7	21.2	32.4	21.7	32.3	21.8	32.0	22.3	31.5	22.9	39
40	33.9	21.2	33.6	21.8	33.3	22.2	33.2	22.4	32.8	22.9	32.4	23.5	40
41	34.8	21.7	34.4	22.3	34.1	22.8	34.0	22.9	33.6	23.5	33.2	24.1	41
42	35.6	22.2	35.2	22.9	34.9	23.3	34.8	23.5	34.4	24.1	34.0	24.7	42
43	36.5	22.8	36.1	23.4	35.7	23.9	35.6	24.0	35.2	24.6	34.8	25.3	43
44	37.3	23.3	36.9	24.0	36.6	24.4	36.5	24.6	36.0	25.2	35.6	25.9	44
45	38.1	23.8	37.7	24.5	37.4	25.0	37.3	25.2	36.9	25.8	36.4	26.4	45
46	39.0	24.4	38.6	25.0	38.2	25.6	38.1	25.7	37.7	26.4	37.2	27.0	46
47	39.9	24.9	39.4	25.6	39.1	26.1	39.0	26.3	38.5	26.9	38.0	27.6	47
48	40.7	25.4	40.3	26.1	39.9	26.7	39.8	26.8	39.3	27.5	38.8	28.2	48
49	41.5	26.0	41.1	26.7	40.7	27.2	40.6	27.4	40.1	28.1	39.6	28.8	49
50	42.4	26.5	41.9	27.2	41.6	27.8	41.4	28.0	41.0	28.7	40.4	29.4	50
Dist.	Dep	Lat.	Dep	Lat.	Dep	Lat	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dist.
	58 Deg		57 Deg.		5 Points		56 Deg.		55 Deg.		54 Deg.		

Dist.	32 Deg.		33 Deg.		3 Points		34 Deg.		35 Deg.		36 Deg.		Dist.
	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	
51	43,2	27,0	42,8	27,8	42,4	28,3	42,3	28,5	41,8	29,2	41,3	30,0	51
52	44,1	27,6	43,6	28,3	43,2	28,9	43,1	29,1	42,6	29,8	42,1	30,6	52
53	44,9	28,1	44,5	28,9	44,1	29,4	43,9	29,6	43,4	30,4	42,9	31,2	53
54	45,8	28,6	45,3	29,4	44,9	30,0	44,5	30,2	44,2	31,0	43,7	31,7	54
55	46,6	29,1	46,1	30,0	45,7	30,6	45,6	30,7	45,1	31,5	44,5	32,3	55
56	47,5	29,7	47,0	30,5	46,6	31,1	46,4	31,3	45,9	32,1	45,3	32,9	56
57	48,3	30,2	47,8	31,0	47,4	31,7	47,3	31,9	46,7	32,7	46,1	33,5	57
58	49,2	30,7	48,7	31,6	48,2	32,2	48,1	32,4	47,5	33,3	46,9	34,1	58
59	50,0	31,3	49,5	32,1	48,0	32,8	48,9	33,0	48,3	33,8	37,7	34,7	59
60	50,9	31,8	50,3	32,7	49,9	33,3	49,7	33,5	49,1	34,4	48,5	35,3	60
61	51,7	32,3	51,2	33,2	50,7	33,9	50,6	34,1	50,0	34,9	49,3	35,9	61
62	52,6	32,9	52,0	33,8	51,5	34,4	51,4	34,7	50,8	35,6	50,2	36,4	62
63	53,4	33,4	52,9	34,3	52,4	35,0	52,2	35,2	51,6	36,1	51,0	37,0	63
64	54,3	33,9	53,7	34,9	53,2	35,5	53,1	35,8	52,4	36,7	51,8	37,6	64
65	55,1	34,4	54,5	35,4	54,0	36,1	53,9	36,3	53,2	37,3	52,6	38,2	65
66	56,0	35,0	55,3	35,9	54,9	36,7	54,7	36,9	54,1	37,9	53,4	38,8	66
67	56,8	35,5	56,2	36,5	55,7	37,2	55,5	37,5	54,9	38,4	54,2	39,4	67
68	57,7	36,0	57,0	37,0	56,5	37,8	56,4	38,0	55,7	39,0	55,0	40,0	68
69	58,5	36,6	57,9	37,6	57,4	38,3	57,2	38,6	56,5	39,5	55,8	40,6	69
70	59,4	37,1	58,7	38,1	58,2	38,9	58,0	39,1	57,3	40,1	56,6	41,1	70
71	60,2	37,6	59,6	38,7	59,0	39,4	58,9	39,7	58,2	40,7	57,4	41,7	71
72	61,0	38,1	60,4	39,2	59,8	40,0	59,7	40,3	59,0	41,3	58,2	42,3	72
73	61,9	38,7	61,2	39,8	60,7	40,6	60,5	40,8	59,8	41,9	59,1	42,9	73
74	62,7	39,2	62,1	40,3	61,5	41,1	61,3	41,4	60,6	42,4	59,9	43,5	74
75	63,6	39,7	62,9	40,8	62,4	41,7	62,2	41,9	61,4	43,0	60,7	44,1	75
76	64,4	40,3	63,8	41,5	63,2	42,2	63,0	42,5	62,3	43,6	61,5	44,7	76
77	65,3	40,8	64,6	41,9	64,0	42,8	63,8	43,0	63,1	44,2	62,3	45,3	77
78	66,1	41,3	65,4	42,5	64,8	43,3	64,7	43,6	63,9	44,7	63,1	45,8	78
79	67,0	41,9	66,3	43,0	65,7	43,9	65,5	44,2	64,7	45,3	63,9	46,4	79
80	67,8	42,4	67,1	43,6	66,5	44,4	66,3	44,7	65,5	45,9	64,7	47,0	80
81	68,7	42,9	68,0	44,1	67,3	45,0	67,1	45,3	66,4	46,5	65,5	47,6	81
82	69,5	43,4	68,8	44,7	68,2	45,5	68,0	45,8	67,2	37,0	66,3	48,2	82
83	70,4	44,0	69,6	45,2	69,0	46,1	68,8	46,4	68,0	47,6	67,1	48,8	83
84	71,2	44,5	70,5	45,8	69,8	46,7	69,6	47,0	68,8	48,2	68,0	49,4	84
85	72,1	45,0	71,3	46,3	70,7	47,2	70,5	47,5	69,6	48,8	68 8	50,0	85
86	72,9	45,6	72,1	46,8	71,5	47,8	71,3	48,1	70,5	49,3	69,6	50,5	86
87	73,8	46,1	73,0	47,3	72,3	48,3	72,1	48,6	71,3	49,9	70,4	51,1	87
88	74,6	46,6	73,8	47,9	73,2	48,9	72,9	49,2	72,1	50,5	71,2	51,7	88
89	75,5	47,2	74,7	48,5	74,0	49,4	73,8	49,8	72,9	51,0	72,0	52,3	89
90	76,3	47,7	75,5	49,0	74,8	50,0	74,6	50,3	73,7	51,6	72,8	42,9	90
91	77,2	48,2	76,3	49,6	75,7	50,6	75,4	50,9	74,5	52,2	73,6	53,5	91
92	78,0	48,7	77,2	50,1	76,5	51,1	76,3	51,4	75,4	52,8	74,4	54,1	92
93	78,9	49,3	78,0	50,6	77,3	51,7	77,1	52,0	76,2	53,3	75,2	54,7	93
94	79,7	49,8	78,9	51,2	78,2	52,2	77,9	52,6	77,0	53,9	76,0	55,2	94
95	80,6	50,3	79,7	51,7	79,0	52,8	78,[illegible]	53,1	77,8	54,5	76,9	55,8	95
96	81,4	50,9	80,5	52,3	79,8	53,3	79,6	53,7	78,6	55,1	77,7	56,4	96
97	82,3	51,4	81,4	52,8	80,6	53,9	80,4	54,2	79,5	55,6	78,5	57,0	97
98	83,1	51,9	82,2	53,4	81,5	54,4	81,2	54,8	80,3	56,2	79,3	57,6	98
99	84,0	52,5	83,1	53,9	82,3	55,0	82 1	55,4	81,1	56,8	80,1	58,2	99
100	84,8	53,0	83,9	54,5	83,1	55,5	82,9	55,9	81,9	57,4	80,9	58,8	100
Dist.	Dep	Lat.	Dep	Lat	Dep	Lat.	Dep	Lat	Dep	Lat.	Dep	Lat.	Dist.
	58 Deg.		57 Deg.		5 Points		56 Deg.		5 Deg.		54 Deg.		

Dist.	3¼ Point		37 Deg.		38 Deg.		39 Deg.		3½ Point		40 Deg.		Dist.
	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	
1	00,8	00,6	00,8	00,6	00,8	00,6	00,8	00,7	00,8	00,6	00,8	00,6	1
2	01,6	01,2	01,6	01,2	01,6	01,2	01,5	01,3	01,5	01,3	01,5	01,3	2
3	02,4	01,8	02,4	01,8	02,4	01,8	02,3	01,9	02,3	01,9	02,3	01,9	3
4	03,2	02,4	03,2	02,4	03,1	02,5	03,1	02,5	03,1	02,5	03,1	02,6	4
5	04,0	03,0	04,0	03,0	03,9	03,1	03,9	03,1	03,9	03,1	03,8	03,2	5
6	04,8	03,6	04,8	03,6	04,7	03,7	04,6	03,8	04,6	03,8	04,6	03,9	6
7	05,6	04,2	05,6	04,2	05,5	04,3	05,4	04,4	05,4	04,4	05,4	04,5	7
8	06,4	04,8	06,4	04,8	06,3	04,9	06,2	05,0	06,2	05,1	06,1	05,1	8
9	07,2	05,4	07,2	05,4	07,1	05,5	07,0	05,7	07,0	05,7	06,9	05,8	9
10	08,0	06,0	08,0	06,0	07,9	06,2	07,8	06,3	07,7	06,3	07,7	06,4	10
11	08,8	06,6	08,8	06,6	08,7	06,8	08,5	06,9	08,5	07,0	08,4	07,1	11
12	09,6	07,1	09,6	07,2	09,4	07,4	09,3	07,5	09,3	07,6	09,2	07,7	12
13	10,4	07,7	10,4	07,8	10,2	08,0	10,1	08,2	10,0	08,2	10,0	08,4	13
14	11,2	08,3	11,2	08,4	11,0	08,7	10,9	08,8	10,8	08,9	10,7	09,0	14
15	12,0	08,9	12,0	09,0	11,8	09,2	11,6	09,4	11,6	09,5	11,5	09,6	15
16	12,8	09,5	12,8	09,6	12,6	09,8	12,4	10,1	12,4	10,1	12,3	10,3	16
17	13,6	10,1	13,6	10,2	13,4	10,5	13,2	10,7	13,1	10,8	13,0	10,9	17
18	14,5	10,7	14,4	10,8	14,2	11,1	13,9	11,3	13,9	11,4	13,8	11,6	18
19	15,3	11,3	15,2	11,4	15,0	11,7	14,8	12,0	14,7	12,0	14,5	12,2	19
20	16,1	11,9	16,0	12,0	15,8	12,3	15,5	12,6	15,5	12,7	15,3	12,9	20
21	16,9	12,5	16,8	12,6	16,5	12,9	16,3	13,2	16,2	13,3	16,1	13,5	21
22	17,7	13,1	17,6	13,2	17,3	13,5	17,1	13,8	17,0	14,0	16,8	14,1	22
23	18,5	13,7	18,4	13,8	18,1	14,2	17,9	14,5	17,8	14,6	17,6	14,8	23
24	19,3	14,3	19,2	14,4	18,9	14,8	18,6	15,1	18,5	15,2	18,4	15,4	24
25	20,1	14,9	20,0	15,0	19,7	15,4	19,4	15,7	19,3	15,9	19,1	16,1	25
26	20,9	15,5	20,8	15,6	20,5	16,0	20,2	16,4	20,1	16,5	19,9	16,7	26
27	21,7	16,1	21,6	16,2	21,3	16,6	21,0	17,0	20,9	17,1	20,7	17,4	27
28	22,5	16,7	22,4	16,8			21,8	17,6	21,6	17,8	21,4	18,0	28
29	23,3	17,3	23,2	17,4			22,5	18,3	22,4	18,4	22,2	18,6	29
30	24,1	17,9	24,0	18,0			23,3	18,9	23,2	19,0	23,0	19,3	30
31	24,9	18,5	24,8	18,6			24,1	19,5	24,0	19,7	23,7	19,9	31
32	25,7	19,1	25,6	19,3			24,9	20,1	24,7	20,3	24,5	20,6	32
33	26,5	19,7	26,4	19,9			25,6	20,8	25,5	20,9	25,3	21,2	33
34	27,3	20,3	27,1	20,5			26,4	21,4	26,3	21,6	26,0	21,9	34
35	28,1	20,8	28,0	21,1			27,2	22,0	27,0	22,2	26,8	22,5	35
36	28,9	21,4	28,7	21,7			28,0	22,7	27,8	22,8	27,6	23,1	36
37	29,7	22,0	29,5	22,3			28,8	23,3	28,6	23,5	28,3	23,8	37
38	30,5	22,6	30,3	22,9			29,5	23,9	29,4	24,1	29,1	24,4	38
39	31,3	23,2	31,1	23,5			30,3	24,5	30,1	24,7	29,9	25,1	39
40	32,1	23,8	31,9	24,1			31,1	25,2	30,9	25,4	30,6	25,7	40
41	32,9	24,4	32,7	24,7			31,9	25,8	31,7	26,0	31,4	26,4	41
42	33,7	25,0	33,5	25,3			32,6	26,4	32,5	26,6	32,2	27,0	42
43	34,5	25,6	34,3	25,9			33,4	27,1	33,2	27,3	32,9	27,6	43
44	35,3	26,2	35,1	26,5			34,2	27,7	34,0	27,9	33,7	28,3	44
45	36,1	26,8	36,0	27,1			35,0	28,3	34,8	28,5	34,5	28,9	45
46	36,9	27,4	36,7	27,7			35,7	29,0	35,6	29,2	35,2	29,6	46
47	37,7	28,0	37,5	28,3			36,5	29,6	36,3	29,8	36,0	30,2	47
48	38,5	28,6	38,3	28,9			37,3	30,2	37,1	30,4	36,8	30,9	48
49	39,3	29,2	39,1	29,5			38,1	30,8	37,9	31,1	37,5	31,5	49
50	40,1	29,8	39,9	30,1			38,9	31,5	38,6	31,7	38,3	32,1	50
	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	
Dist.	4¾ Point		53 Deg.		52 Deg.		51 Deg.		4½ Point		50 Deg.		Dist.

Dift.	3 ¼ Point		37 Deg.		38 Deg.		39 Deg.		3½ Point		40 Deg.		Dift.
	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep.	Lat.	Dep	Lat.	Dep	
51	41.0	30.4	40.7	30.7	40.2	31.4	39.6	32.1	39.4	32.3	39.1	32.8	51
52	41.8	31.0	41.5	31.3	41.0	32.0	40.4	32.7	40.2	33.0	39.8	33.4	52
53	42.6	31.6	42.3	31.9	41.8	32.6	41.2	33.3	41.0	33.6	40.6	34.1	53
54	43.4	32.2	43.1	32.5	42.5	33.2	42.0	34.0	41.7	34.3	41.4	34.7	54
55	44.2	32.8	43.9	33.1	43.3	33.9	42.7	34.6	42.5	34.9	42.1	35.4	55
56	45.0	33.3	44.7	33.7	44.1	34.5	43.5	35.2	43.3	35.5	42.9	36.0	56
57	45.8	33.9	45.5	34.3	44.9	35.1	44.3	35.9	44.1	36.2	43.7	36.6	57
58	46.6	34.5	46.3	34.9	45.7	35.8	45.1	36.5	44.8	36.8	44.4	37.3	58
59	47.4	35.1	47.1	35.5	46.5	36.3	45.8	37.1	45.6	37.4	45.2	37.9	59
60	48.2	35.7	47.9	36.1	47.3	36.9	46.6	37.8	46.4	38.1	46.0	38.6	60
61	49.0	36.3	48.7	36.7	48.1	37.5	47.4	38.4	47.1	38.7	46.7	39.9	61
62	49.8	36.9	49.5	37.3	48.9	38.2	48.2	39.0	47.9	39.3	47.5	39.9	62
63	50.6	37.5	50.3	37.9	49.6	38.8	49.0	39.6	48.7	40.0	48.3	40.5	63
64	51.4	38.1	51.1	38.5	50.4	39.4	49.7	40.3	49.5	40.6	49.0	41.2	64
65	52.2	38.7	51.9	39.1	51.2	40.0	50.5	40.9	50.2	41.2	49.8	41.8	65
66	53.0	39.3	52.7	39.7	52.0	40.6	51.3	41.5	51.0	41.9	50.5	42.4	66
67	53.8	39.9	53.5	40.3	52.8	41.2	52.1	42.2	51.8	42.5	51.3	43.1	67
68	54.6	40.5	54.3	40.9	53.6	41.9	52.8	42.8	52.6	43.1	52.1	43.7	68
69	55.4	41.1	55.1	41.5	54.4	42.5	53.6	43.4	53.3	43.8	52.9	44.4	69
70	56.2	41.7	55.9	42.1	55.2	43.1	54.4	44.0	54.1	44.4	53.6	45.0	70
71	57.0	42.3	56.7	42.7	55.9	43.7	55.2	44.7	54.9	45.0	54.4	45.6	71
72	57.8	42.9	57.5	43.3	56.7	44.3	55.9	45.3	55.7	45.7	55.1	46.3	72
73	58.6	43.5	58.3	43.9	57.5	44.9	56.7	45.9	56.4	46.3	55.9	46.9	73
74	59.4	44.1	59.1	44.5	58.3	45.6	57.5	46.6	57.2	46.9	56.7	47.6	74
75	60.2	44.7	59.9	45.1	59.2	46.2	58.3	47.2	58.0	47.6	57.4	48.2	75
76	61.0	45.3	60.7	45.7	60.0	46.8	59.1	47.8	58.7	48.2	58.2	48.9	76
77	61.8	45.9	61.5	46.3	60.7	47.4	59.8	48.5	59.5	48.8	59.0	49.5	77
78	62.7	46.5	62.3	46.9	61.5	48.0	60.6	49.1	60.3	49.5	59.7	50.1	78
79	63.5	47.1	63.1	47.5	62.2	48.6	61.4	49.7	61.1	50.1	60.5	50.8	79
80	64.3	47.7	63.9	48.1	63.0	49.3	62.2	50.3	61.8	50.7	61.3	51.4	80
81	65.1	48.3	64.7	48.7	63.8	49.9	62.9	51.0	62.6	51.4	62.0	52.1	81
82	65.9	48.8	65.5	49.3	64.6	50.5	63.7	51.6	63.4	52.0	62.8	52.7	82
83	66.7	49.4	66.3	49.9	65.4	51.1	64.5	52.2	64.2	52.6	63.6	53.4	83
84	67.5	50.0	67.1	50.5	66.2	51.7	65.3	52.9	64.9	53.3	64.3	54.0	84
85	68.3	50.6	67.9	51.1	67.0	52.3	66.1	53.5	65.7	53.9	65.1	54.6	85
86	69.1	51.2	68.7	51.7	67.8	52.9	66.8	54.1	66.5	54.6	65.9	55.3	86
87	69.9	51.8	69.5	52.4	68.6	53.6	67.6	54.8	67.2	55.2	66.6	55.9	87
88	70.7	52.4	70.3	53.0	69.3	54.2	68.4	55.4	68.0	55.8	67.4	56.6	88
89	71.5	53.0	71.1	53.6	70.1	54.8	69.2	56.0	68.8	56.4	68.2	57.2	89
90	72.3	53.6	71.9	54.2	70.9	55.4	69.9	56.6	69.6	57.1	68.9	57.4	90
91	73.1	54.2	72.7	54.8	71.7	56.0	70.7	57.3	70.3	57.7	69.7	58.5	91
92	73.9	54.8	73.5	55.4	72.5	56.6	71.5	57.9	71.1	58.4	70.5	59.1	92
93	74.7	55.4	74.3	56.0	73.3	57.3	72.3	58.5	71.9	59.0	71.2	59.8	93
94	75.5	56.0	75.1	56.6	74.1	57.9	73.0	59.2	72.7	59.6	72.0	60.4	94
95	76.3	56.6	75.9	57.2	74.9	58.5	73.8	59.8	73.4	60.3	72.8	61.1	95
96	77.1	57.2	76.7	57.8	75.6	59.1	74.6	60.4	74.2	60.9	73.5	61.7	96
97	77.9	57.8	77.5	58.4	76.4	59.7	75.4	61.0	75.0	61.5	74.3	62.1	97
98	78.7	58.4	78.3	59.0	77.2	60.3	76.2	61.7	75.7	62.2	75.2	63.0	98
99	79.5	59.0	79.1	59.6	78.0	60.9	76.9	62.3	76.5	62.8	75.8	63.6	99
100	80.3	59.6	79.9	60.2	78.8	61.6	77.7	62.9	77.3	63.4	76.6	64.3	100
Dift.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dift.
	4¾ Point		53 Deg.		52 Deg.		51 Deg.		4½ Point		50 Deg.		

Lat.	Dep	Dist.
,7	00,7	1
,4	01,4	2
,1	02,1	3
,8	02,8	4
,5	03,5	5
,2	04,2	6
,9	04,9	7
,7	05,7	8
,4	06,4	9
,1	07,1	10
,8	07,8	11
,5	08,5	12
,2	09,2	13
,9	09,9	14
,6	10,6	15
,3	11,3	16
,0	12,0	17
,7	12,7	18
,4	13,4	19
,1	14,1	20
,8	14,8	21
,5	15,5	22
,3	16,3	23
,0	17,0	24
,7	17,7	25
,4	18,4	26
,1	19,1	27
,8	19,8	28
,5	20,5	29
,2	21,2	30
,9	21,9	31
,6	22,6	32
,3	23,3	33
,0	24,0	34
,7	24,7	35
,4	25,4	36
,1	26,1	37
,9	26,9	38
,6	27,6	39
,3	28,3	40
,0	29,0	41
,7	29,7	42
,4	30,4	43
,1	31,1	44
,8	31,8	45
,5	32,5	46
,2	33,2	47
,9	33,9	48
,6	34,6	49
,3	35,3	50
Dep.	Lat.	Dist.

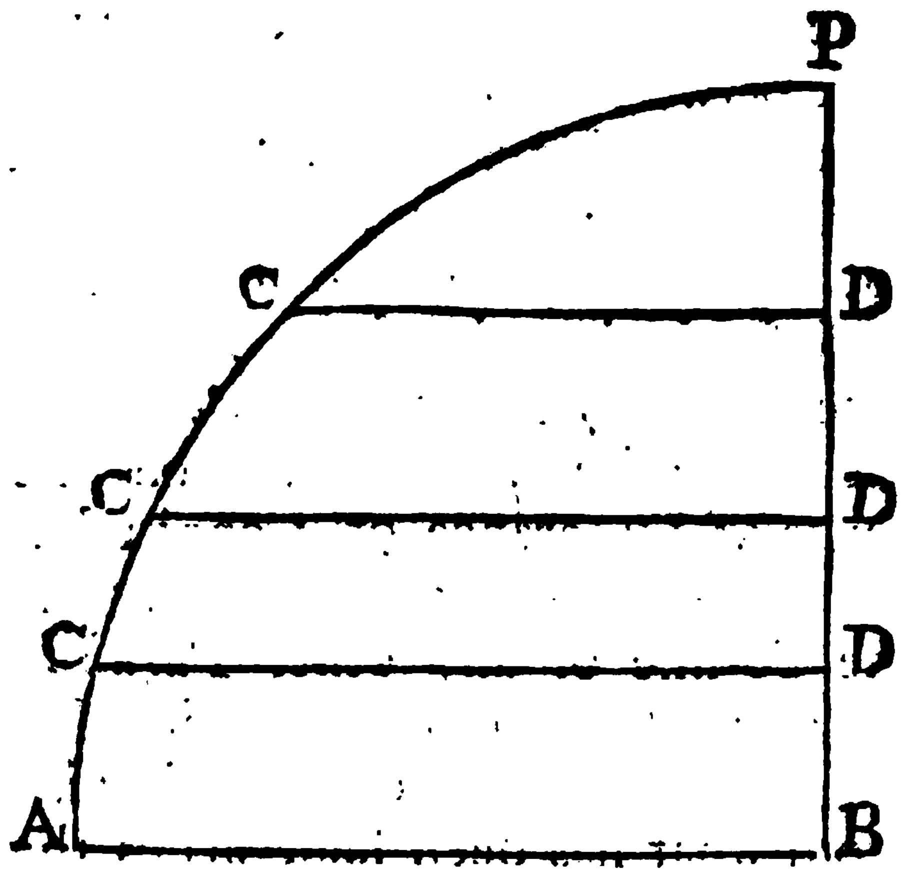
Points

Dist.	41 Deg		42 Deg.		3¾ Point		43 Deg.		44 Deg.		4 Points		Dist.
	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	
51	38,5	33,5	37,9	34,1	37,8	34,2	37,3	34,8	36,7	35,4	36,1	36,1	51
52	39,2	34,1	38,6	34,8	38,5	34,9	38,0	35,5	37,4	36,1	36,8	36,8	52
53	40,0	34,8	39,4	35,5	39,3	35,6	38,8	36,1	38,1	36,8	37,5	37,5	53
54	40,8	35,4	40,1	36,1	40,0	36,3	39,5	36,8	38,8	37,5	38,2	38,2	54
55	41,5	36,0	40,9	36,8	40,7	36,9	40,2	37,5	39,6	38,2	38,9	38,9	55
56	42,3	36,7	41,6	37,5	41,5	37,6	41,0	38,2	40,3	38,9	39,6	39,6	56
57	43,0	37,4	42,4	38,1	42,2	38,3	41,7	38,9	41,0	39,6	40,3	40,3	57
58	43,8	38,1	43,1	38,8	43,0	38,9	42,4	39,5	41,7	40,3	41,0	41,0	58
59	44,5	38,7	43,8	39,5	43,7	39,6	43,1	40,2	42,4	41,0	41,7	41,7	59
60	45,3	39,4	44,6	40,1	44,5	40,3	43,8	40,9	43,2	41,7	42,4	42,4	60
61	46,0	40,0	45,3	40,8	45,2	41,0	44,6	41,7	43,9	42,4	43,1	43,1	61
62	46,8	40,7	46,1	41,5	45,9	41,6	45,3	42,3	44,6	43,1	43,8	43,8	62
63	47,6	41,3	46,8	42,2	46,7	42,3	46,1	43,0	45,3	43,8	44,5	44,5	63
64	48,3	42,0	47,5	42,8	47,4	43,0	46,8	43,6	46,0	44,5	45,3	45,3	64
65	49,1	42,6	48,3	43,5	48,2	43,6	47,5	44,3	46,8	45,1	46,0	46,0	65
66	49.8	43,3	49,0	44,2	48,9	44.3	48,3	45,0	47,5	45,8	46,7	46,7	66
67	50,6	44,0	49,8	44,8	49,6	45,0	49,0	45,7	48,2	46,5	47,4	47,4	67
68	51,3	44,6	50,5	45,5	50,4	45,7	49,7	46,4	48,9	47,2	48,1	48,1	68
69	52,1	45,3	51,3	46,2	51,1	46,3	50,5	47,1	49,6	47,9	48,8	48,8	69
70	52,8	45,9	52,0	46,8	51,9	47,0	51,2	47,7	50,3	48,6	49,5	49,5	70
71	53,6	46,6	52,8	47,5	52,6	47,7	51,9	48,4	51,1	49,3	50,2	50,2	71
72	54,3	47,2	53,5	48,2	53,3	48,3	52,7	49,1	51,8	50,0	50,9	50,9	72
73	55,1	47,9	54,2	48,8	54,1	49,0	53,4	49,8	52,5	50,7	51,6	51,6	73
74	55,9	48,5	55,0	49,5	54,8	49,7	54,1	50,5	53,2	51,4	52,3	52,3	74
75	56,8	49,2	55,7	50,2	55,6	50,4	54,8	51,1	53,9	52,1	53,0	53,0	75
76	57,4	49,9	56,5	50,9	56,3	51,0	55,6	51,8	54,7	52,8	53,7	53,7	76
77	58,1	50,5	57,2	51,5	57,1	51,7	56,3	52,5	55,4	53,5	54,4	54,4	77
78	58,9	51,2	58,0	52,1	57,8	52,4	57,0	53,2	56,1	54,2	55,2	55,2	78
79	59,6	51,8	58,7	52,8	58,5	53,0	57,8	53,9	56,8	54,9	55,9	55,9	79
80	60,4	52,5	59,4	53,5	59,3	53,7	58,5	54,6	57,5	55,6	56,6	56,6	80
81	61,1	53,1	60,2	54,2	60,0	54,4	59,2	55,2	58,3	56,3	57,3	57,3	81
82	61,9	53,8	60,9	54,9	60,8	55,1	60,0	55,9	59,0	57,0	58,0	58,0	82
83	62,6	54,5	61,7	55,5	61,5	55.7	60,7	56,6	59,7	57,6	58,7	58,7	83
84	63,4	55,1	62,4	56,2	62,2	56,4	61,4	57,3	60,4	58,3	59,4	59,4	84
85	64,2	55,9	63,2	56,9	63,0	57,1	62,2	58,0	61,1	59,0	60,1	60,1	85
86	64,9	56,4	63,9	57.5	63,7	57,7	63,0	58,6	61,9	59,7	60,8	60,8	86
87	65,7	57,1	64,7	58,2	64,5	58,4	63,6	59.3	62,6	60,4	61,5	61,5	87
88	66,4	57,7	65,4	58,9	65,2	59,1	64,4	60,0	63,3	61,1	62,2	62,2	88
89	67,2	58,4	66,1	59,6	65.9	59,8	65,1	60,7	64,0	61,8	62,9	62,9	89
90	67,9	59,0	66,9	60,2	66,7	60,4	65,8	61,4	64,7	62,5	63,6	63,6	90
91	68,7	59,7	67,6	60,9	67,4	61,1	66,5	62,1	65,5	63,2	64,3	64,3	91
92	69,4	60,4	68,4	61,6	68,2	61,8	67,3	62,7	66,2	63,9	65,0	65,0	92
93	70,2	61,0	69,1	62,2	68,9	62,4	68,0	63,4	66,9	64,6	65,8	65,8	93
94	71,0	61,7	69,9	62,9	69,6	63,1	68,7	64,1	67,6	65,3	66,5	66,5	94
95	71,7	62,3	70,6	63,6	70,4	63,8	69,5	64,8	68,3	66,0	67,2	67,2	95
96	72,5	63,0	71,3	64,2	71,1	64,5	70,2	65,5	69,1	66,7	67,9	67,9	96
97	73,2	63.6	72,1	64,9	71,9	65,1	70,9	66,1	69,8	67,4	68,6	68,6	97
98	74,0	64,3	72,8	65,6	72,6	65,8	71,7	66,8	70,5	68,1	69,3	69,3	98
99	74,7	65,0	73,6	66,2	73,4	66,5	72,4	67,5	71,2	68,8	70,0	70,0	99
100	75,5	65,6	74,3	66,9	74,1	67,2	73,1	68,2	71,9	69,5	70,7	70,7	100
Dist.	Dep	Lat	Dep	Lat	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dep	Lat.	Dist.
	49 Deg.		48 Deg.		4¼ Point		47 Deg.		46 Deg.		4 Points		

SECT. VIII.

Of Parallel Sailing.

1. SINCE the *Parallels of Latitude* do always decrease the nearer they approach the *Pole*, it is plain a Degree on any of them must be less than a Degree upon the *Equator*. Now in order to know the length of a Degree on any of them; let PB represent half the Earth's Axis, PA, a Quadrant of a *Meridian*, and consequently A, a



Point on the *Equator*, C a Point on the *Meridian*, and CD a Perpendicular from that Point upon the Axis, which plainly will be the Sine of CP the Distance of that Point from the Pole, or the Co-sine of CA it's Distance from the Equator, and CD, will be to AB, as the Sine of CP or Co-sine of CA, is to the Radius. Again, if the Quadrant PAB be turn'd round upon the Axis PB,

'tis plain the Point A will describe the Circumference of the *Equator* whose Radius is AB, and any other Point C upon the Meridian will describe the Circumference of a *Parallel*, whose Radius is CD.

Cor. 1. Hence (because the Circumferences of Circles are as their *Radii*) it follows, that the Circumference of any *Parallel*, is to the Circumference of the *Equator*, as the Co-sine of it's Latitude, is to Radius.

Cor. 2 And since the wholes are as their similar Parts, it will be, as the length of a Degree on any *Parallel*, is to the length of a Degree upon the *Equator*, so is the Co-sine of the Latitude of that *Parallel*, to Radius.

Cor. 3. Hence as Radius, is to the Co-sine of any Latitude, so is the Minutes of Difference of Longitude between two *Meridians*, or their Distance in Miles upon the Equator, to the Distance of these two Meridians on the *Parallel* in Miles.

Cor. 4. And as the Co-sine of any *Parallel* is to Radius, so is the length of any Arch on that *Parallel* (intercepted between two *Meridians*) in Miles, to the length of a similar Arch on the *Equator*, or Minutes of Difference of Longitude.

Cor. 5. Also as the Co-sine of any one *Parallel*, is to the Co-sine of any other *Parallel*, so is the length of any Arch on the first, in Miles, to the length of the same Arch on the other in Miles.

2. From what has been said, arises the Solution of the several Cases of *Parallel Sailing*, which are as follow.

CASE I.

Given the Difference of Longitude between two Places, both lying on the same Parallel, *to find the Distance between those Places.*

Example 1.

Example 1.

Suppose a Ship in the Latitude of 54°, 20′ North, sails directly West on that *Parallel* till she has differ'd her Longitude 12°, 45′. Required the Distance sail'd on that *Parallel.*

First, The Difference of Longitude reduced into Minutes, or nautical Miles, is 765′, which is the Distance between the Meridian sail'd from and the Meridian come to, upon the *Equator*; then to find the Distance between these Meridians on the *Parallel* of 54°, 20′, or the Distance sail'd, it will be, by *Cor.* 3. of the last *Article*,

As Radius - - - - -		10.00000
is to the Co-sine of the Lat.	54°, 20′	9.76572
so is the Minutes of Diff. Long.	765 -	2.88366
to the Distance on the Parallel	446.1 -	2.64938

Example 2.

A Degree on the *Equator* being 60 Minutes, or nautical Miles. Required the length of a Degree on the *Parallel* of 51°, 32′.

By *Cor.* 3. of the last *Article*, it will be

As Radius - - - - - -		10.00000
is to the Co-sine of the Lat.	51°, 32′ -	9.79383
so is the Min. in 1 Deg. on the *Eq.*	60 -	1.77815
to - - - - - -	37.32 -	1.57198

the Miles answering to a Degree on the *Parallel* of 51°, 32′.

By this *Problem* the following Table is construct-ed, shewing the Geographic Miles answering to a Degree on any *Parallel* of Latitude; in which you may observe, that the Columns mark'd at the Top with *D. L.* contain the Degrees of Latitude belonging to each *Parallel*; and the adjacent Columns mark'd at the Top, *Miles*, contain the Miles answering to a Degree upon these *Parallels*.

A Table *shewing how many Miles answer to a Degree of* Longitude, *at every Degree of* Latitude.

D. L.	*Miles*	*D. L.*	*Miles*	*D. L.*	*Miles*	*D. L.*	*Miles*	*D. L.*	*Miles*
1	59.99	19	56.73	37	47.92	55	34.41	73	17.54
2	59.97	20	56.38	38	47.28	56	33.55	74	16.53
3	59.92	21	56.01	39	46.62	57	32.68	75	15.52
4	59.86	22	55.63	40	45.95	58	31.79	76	14.51
5	59.77	23	55.23	41	45.28	59	30.90	77	13.50
6	59.67	24	54.81	42	44.95	60	30.00	78	12.48
7	59.56	25	54.38	43	43.88	61	29.09	79	11.45
8	59.42	26	53.93	44	43.16	62	28.17	80	10.42
9	59.26	27	53.46	45	42.43	63	27.24	81	9.38
10	59.08	28	52.97	46	41.68	64	26.30	82	8.35
11	58.89	29	52.47	47	40.92	65	25.36	83	7.32
12	58.68	30	51.96	48	40.15	66	24.41	84	6.28
13	58.46	31	51.43	49	39.36	67	23.45	85	5.23
14	58.22	32	50.88	50	38.57	68	22.48	86	4.18
15	57.95	33	50.32	51	37.76	69	21.50	87	3.14
16	57.67	34	49.74	52	36.94	70	20.52	88	2.09
17	57.37	35	49.15	53	36.11	71	19.54	89	1.05
18	57.06	36	48.54	54	35.26	72	18.55	90	0.00

Tho' this Table does only shew the Miles answering to a Degree of any *Parallel*, whose Latitude consists of a whole Number of Degrees; yet it may be made to serve for any *Parallel*, whose Latitude is some Number of Degrees and Minutes, by making the following proportion, *viz.*

As 1 Degree, or 60 Minutes, is to the Difference between the Miles answering to a Degree in the next greater and next less Tabular Latitude than that

that proposed, so is the Excess of the proposed Latitude above the next less Tabular Latitude, to a proportional part; which, subtracted from the Miles answering to a Degree of Longitude in the next less Tabular Latitude, will give the Miles answering to a Degree in the proposed Latitude.

Example.

Required to find the Miles answering to a Degree on the *Parallel* of 56°, 44′.

First, The next less *Parallel* of Latitude in the Table, than that proposed, is that of 56°, a Degree of which (by the Table) is equal to 33.55 Miles; and the next greater Parallel of Latitude in the Table, than that proposed, is that of 57°, a Degree of which is (by the Table) equal to 32.68 Miles; the Difference of these is .87, and the Distance between these *Parallels* is 1 Degree or 60 Minutes; also the Distance between the *Parallel* of 56°, and the proposed *Parallel* of 56°, 44′ is 44 Minutes; then by the preceeding proportion it will be: As 60, is to .87, so is 44, to .638, the Difference between a Degree on the *Parallel* of 56°, and a Degree on the *Parallel* of 56°, 44′, which therefore taken from 33.55, the Miles answering to a Degree on the *Parallel* of 56°, leaves 32.912 the Miles answering to a Degree on the *Parallel* of 56°, 44′, as was required.

CASE 2.

The Distance sail'd in any Parallel *of Latitude, or the Distance between any two Places on that* Parallel *being given, to find the Difference of Longitude.*

Example.

Example.

Suppose a Ship in the Latitude of 55°, 36′ North, ſails directly Eaſt 685.6 Miles. Required how much ſhe has differ'd her Longitude.

By *Cor.* 4. *Art.* 1. of this *Section* it will be

As the Co-ſine of the Lat.	55°, 36′	-	9.75202
is to Radius	- - - -		10.00000
ſo is the Diſtance ſail'd	- 685.6	-	2.83607
to Min. of Diff. of Long.	- 1213	-	3.08405

which reduc'd into Degrees, by dividing by 60, makes 20°, 13′ the Difference of Longitude the Ship has made.

This may alſo be ſolv'd by help of the foregoing Table, *viz.* by finding from it, the Miles anſwering to a Degree on the propoſed *Parallel*, and dividing with this the given number of Miles, the Quotient will be the Degrees and Minutes of Diff. of Longitude required.

Thus in the laſt *Example*; I find, from the foregoing Table, that a Degree on the Parallel of 55°, 36′ is equal to 33.89 Miles; by this I divide the propoſed number of Miles 685.6 and the Quotient is 20.23 Degrees, *i. e.* 20°, 13′, the Difference of Longitude required.

CASE 3.

The Difference of Longitude between two Places on the ſame Parallel, *and the Diſtance between them being given, to find the Latitude of that* Parallel.

Example.

Example

Suppose a Ship sails on a certain *Parallel* directly West 624 Miles, and then has differ'd her Longitude 18°, 46′ or 1126 Miles. Required the Latitude of the *Parallel* she sail'd upon.

By *Cor.* 3. *Art.* 1. of this *Section* it will be

As the Min. of Diff. Long.	1126 -	3.05154
is to the Distance sail'd - -	624 -	2.79518
so is Radius - - - - -		10.00000
to the Co-sine of the Lat. -	56°, 21′	9.74364

consequently the Latitude of the Ship or *Parallel* she sail'd upon was 56°, 21′.

From what has been said, may be solv'd the following Problems.

PROB. 1.

Suppose two Ships in the Latitude of 46°, 30′ North, distant asunder 654 Miles, sail both directly North 256 Miles, and consequently are come to the Latitude of 50°, 46′ North. Required their Distance on that *Parallel*.

By *Cor.* 5. of *Art.* 1. of this *Section* it will be

As the Co-sine of - -	46°, 30′ .	9.83781
is to the Co-sine of - -	50 , 46 -	9.80105
so is - - - - - - -	654 - -	2.81558
to - - - - - - - - -	601 - -	2.77882

the Distance between the Ships when on the *Parallel* of 50°, 46′.

PROB. 2.

PROB. 2.

Suppose two Ships in the Latitude of 45°, 48′ North, distant asunder 846 Miles, sail directly North till the distance between them is 624 Miles. Required the Latitude come to, and the distance sail'd.

By *Cor.* 5. of *Art.* 1. of this *Section* it will be

As their first Distance - -	846 - -	2.92737
is to their second Distance -	624 - -	2.79518
so is the Co-sine of - -	45°, 48′ -	9.84334
to the Co-sine of - - -	59 , 04 -	9.71115

the Latitude of the *Parallel* the Ships are come to.

Consequently to find their Distance sail'd,

From the Latitude come to - - -	59°, 04′
subtract the Latitude sail'd from - -	45 , 48
and there remains - - - - - - -	13 , 16

equal to 796 Miles, the difference of Latitude or distance sail'd.

3. Tho' in solving the Problems in this Section, we supposed the Earth to be really spherical, yet it is not so, but rather an *oblate Spheroid* having the Diameter of the Equator about 34 Miles longer than the Axis; which makes the length of a Degree on the Meridian, near the Pole, about a Mile longer than the length of a Degree near the Equator; and the *Radii* of the *Parallels* instead of being Sines in a Circle, will be *Ordinates* to the lesser Axe of an *Ellipse*. Consequently the true length of a Degree on any *Parallel*, will somewhat differ from its length on the Supposition of the Earth's being a Sphere; but this difference is so small, that in all *nautical* Cases it may safely be neglected.

SECT. IX.

SECT. IX.

Of Middle Latitude Sailing.

1. WHEN two Places lie both on the same *Parallel*, we shew'd, in the last Section, how from the difference of Longitude given, to find the Miles of Easting or Westing between them, *& e contra*; but when two Places lie not on the same *Parallel*, then their difference of Longitude cannot be reduc'd to Miles of Easting or Westing on the *Parallel* of either Place; for if counted on the *Parallel* of that Place that has the greatest Latitude it would be too small, and if on the *Parallel* of that Place having the least Latitude it would be too great. Hence the common Way of reducing the Difference of Longitude between two Places, lying on different *Parallels*, to Miles of Easting or Westing, *& e contra*, is by counting it on the middle *Parallel* between the Places, which is found by adding the Latitudes of the two Places together, and taking half the Sum, which will be the Latitude of the middle *Parallel* required. And hence arises the the Solution of the following Cases.

CASE I.

The Latitudes of two Places, and their Difference of Longitude, given, to find the direct Course and Distance.

Example.

Requir'd the direct Course and Distance between the *Lizard* in the Latitude of 50°, 00′ N. and

Longitude of 5° , 14′ W, and *St. Vincent* in the Latitude of 17° , 10′ N. and Longitude of 24° 20′ W.

	°	′	
First, To the Latitude of the *Lizard* -	50	00	N
add the Latitude of *St. Vincent* - -	17	10	
The Sum is - - - - - - - - - -	67	10	
Half the Sum or Latitude of the middle *Parallel* is - - -	33	35	N
Alſo the Diff. of Latitude is - - - -	32	50	

equal to 1970 Miles of ſouthing. Again,

	°	′	
From the Long. of *St. Vincent* - -	24	20	W
take the Long. of the *Lizard* - - -	05	14	W
there remains - - - - - - - - -	19	06	

equal to 1146 *Min.* of Diff. of Long. Weſt.

Then for the Miles of Weſting, or Departure, it will be, by *Caſe* 1. *of Parallel Sailing*,

As Radius - - - - - - - - - -		10.00000
is to the Co-ſine of the middle Parallel	33° 35′ - -	9.92069
ſo is Min. Diff. of Long.	- 1146 - -	3.05918
to the Miles of Weſting	- 954.7 - -	2.97987

And for the Courſe it will be, by *Caſe* 4. *of Plain Sailing*,

As the Diff. of Lat. - -	1970 - -	3.29447
is to Radius - - - - - - - - - -		10.00000
ſo is the Departure - -	954.7 -	2.97987
to the Tang. of the Courſe	25° 51′ -	9.68540

which becauſe it is between South and Weſt will be S S W ¼ Weſt nearly.

For the Diſtance it will be, by the ſame *Caſe*,

As Radius - - - - - - - - - - -		10.00000
is to the Diff. of Lat. -	1970 - -	3.29447

ſo

so is the Secant of the Course	25°, 51′	-	10.04579
to the Distance - - - - -	2189	-	3.34026

whence the direct Course and Distance from the *Lizard* to *St. Vincent* is S S W ¼ W, 2189 Miles.

CASE 2.

One Latitude, Course and Distance sail'd, being given, to find the other Latitude, and Difference of Longitude.

Example.

Suppose a Ship in the Latitude of 50°, 00′ North, sails South 50°, 06′ West 150 Miles. Required the Latitude the Ship has come to, and how much she has differ'd her Longitude.

First, For the difference of Latitude it will be, by *Case* 1. *of Plain Sailing*,

As Radius - - - - - -		10.00000
is to the Distance - -	150 -	2.17609
so is the Co-sine of the Course	50°, 06′	9.80716
to the Diff. of Latitude -	96.22	1.98325

equal to 1°, 36′, and since the Ship is sailing towards the Equator, Therefore,

From the Latitude she was in - -	50°, 00′
take the diff. of Latitude - -	1 , 36
and there remains - - -	48 , 24

the Latitude she has come to North. Consequently the Latitude of the middle *Parallel* will be 49°, 12′.

Then for Departure or Westing it will be, by the same *Case*,

As Radius	- - - - - - -		10.00000
is to the Distance	- -	150 - - -	2.17609
so is the Sine of the Course		50°, 06′ -	9.88489
to the Departure	- -	115.1 - -	2.06098

and for the difference of Longitude, it will be, by *Case* 2. *of Parallel Sailing*,

As the Co-sine of the mid. *Par.*		49°, 12′	9.81519
is to Radius	- - - - -		10.00000
so is the Departure	- -	115.1 -	2.06098
to the min. Diff. of Longitude		176.1 -	2.24579

equal to 2°, 56′, which is the difference of Longitude, the Ship has made Westerly.

CASE 3.

Course and Difference of Latitude given, to find the Distance sail'd, and Difference of Longitude.

Example.

Suppose a Ship in the Latitude of 53°, 34′ North, sails SE*b*S, till by Observation she's found to be in the Latitude of 51°, 12′, and consequently has differ'd her Latitude 2°, 22′, or 142 Miles. Required the Distance sail'd, and the difference of Longitude.

First, For the Departure, it will be (by *Case* 2. *of Plain Sailing*)

As Radius	- - - - - -		10.00000
is to the Diff. of Latitude	-	142 -	2.15229
so is the Tang. of Course	-	33°, 45′	9.82489
to the Departure	- - -	94.88	1.97718

And for the Distance, it will be, by the same *Case*,

As

As Radius	- - - - - - - - - -		10.00000
is to the diff. of Lat.	- -	142 -	2.15229
ſo is the Secant of Courſe	-	$33^\circ, 45'$	10.08015
to the Diſtance	- - - -	170.8 -	2.23244

Then, ſince the Latitude ſail'd from was 53°, $34'$ North, and the Latitude come to 51°, $12'$ North; therefore the middle *Parallel* will be 47°, $23'$, and conſequently for the difference of Longitude, it will be (by *Caſe* 2. *of Parallel Sailing*)

As the Co-ſine of the mid. *Par.*		$47^\circ, 23'$	9.83065
is to the Departure	- -	94.88 -	1.97718
ſo is Radius	- - - - -		10.00000
to min. of diff. of Longit.	- -	140 -	2.14653

equal to 2°, $20'$, the difference of Longitude Eaſterly.

CASE 4.

Difference of Latitude, and Diſtance ſail'd, given, to find the Courſe and Difference of Longitude.

Example.

Suppoſe a Ship in the Latitude of 43°, $26'$ North, ſails between South and Eaſt, 246 Miles, and then is found by Obſervation to be in the Latitude of 41°, $06'$ North. Required the direct Courſe and Difference of Longitude.

Firſt, For the Courſe it will be, by *Caſe* 3. *of Plain Sailing*,

As the Diſtance	- -	246 -	2.39094
is to Radius	- - - - -		10.00000

ſo

so is the Diff. of Latitude	140	- -	2.14613
to the Co-sine of the Course	55°, 19′		9.75519

which, because the Ship sails between South and East, will be South 55°, 19′ East, or S E *b* E nearly.

Then for Departure it will be, by the same *Case*,

As Radius	- - - - -	-	10.00000
is to the Distance	- 246	-	2.39094
so is the Sine of the Course	55°, 19′	-	9.91504
to the Departure	- - 202.3	-	2.30598

Lastly, For the difference of Longitude, it will be, by *Case* 2. *of Parallel Sailing.*

As the Co-sine of the mid. *Par.*	42°, 16′		9.86924
is to the Departure - - -	202.3	-	2.30598
so is Radius - - - - - - -	-		10.00000
to min. of Diff. of Longit. -	273.3	-	2.43674

equal to 4°, 33′, the difference of Longitude Easterly.

CASE 5.

Course and Departure given, to find Difference of Latitude, Difference of Longitude, and Distance sail'd.

Example.

Suppose a Ship in the Latitude of 48°, 23′ North, sails S W *b* S, till she has made of Westing 123 Miles. Required the Latitude come to, the difference of Longitude, and the Distance sail'd.

First, For the Distance it will be, by *Case* 6. *of Plain Sailing*,

As

As the Sine of the Courſe	33°, 45′	-	9.74474
is to the Departure - -	123	- -	2.08991
ſo is Radius - - - -		-	10.00000
to the Diſtance - - - -	221.4	-	2.34517

And for the difference of Latitude it will be, by the ſame *Caſe*,

As the Tang. of Courſe -	33°, 45′	-	9.82489
is to the Departure - -	123	- -	208991
ſo is Radius - - - - - - - -			10.00000
to the Diff. of Latitude -	184	- -	2.26502

equal to 3°, 04′, and ſince the Ship is ſailing towards the Equator, the Latitude come to will be 45°, 19′ North; and conſequently the middle *Parallel* will be 46°, 51′.

Then to find the difference of Longitude it will be, by *Caſe* 2. *of Parallel Sailing*,

As the Co-ſine of mid. *Par.*	46°, 51′	-	9.83500
is to Departure - - - -	123	- -	2.08991
ſo is Radius - - - - - - - - -			10.00000
to min. of Diff. of Longit.	180	- -	2.25491

which is equal to 3°, 00′, the difference of Longitude Weſterly.

CASE 6.

Difference of Latitude and Departure given, to find Courſe, Diſtance, and Difference of Longitude.

Example.

Suppoſe a Ship in the Latitude of 46°, 37′ North, ſails between South and Eaſt, till ſhe has made of Eaſting, 146 Miles and is then found by

by Observation to be in the Latitude of 43°, 24′ North. Required the Course, Distance, and difference of Longitude.

First, By *Case* 4. *of Plain Sailing*, it will be for the Course,

As the Diff. of Latitude -	193	-	2.28556
is to Departure - -	146	-	2.16137
so is Radius - - - -		-	10.00000
to the Tang. of the Course -	36°, 55′		9.87581

which because the Ship is sailing between South and East, will be South 36°, 55′ East, or SE b S ¼ East nearly.

For the Distance it will be, by the same *Case*,

As Radius - - - - - - - - -			10.00000
is to the Diff. of Latitude -	193	-	2.28556
so is the Sec. of the Course	36°, 55′		10.09718
to the Distance - - -	241.4	-	2.38274

Then for the difference of Longitude it will be, by *Case* 2. *of Parallel Sailing*,

As the Co-sine of the mid. *Par.*	45°, 00′		9.84949
is to the Departure - -	146	-	2.16137
so is Radius - - - - - - - -		-	10.00000
to min. of diff. of Longit. -	205	-	2.31188

equal to 3°, 25′, the difference of Longitude Easterly.

CASE 7.

Distance and Departure given, to find Difference of Latitude, Course, and Difference of Longitude.

Example.

Example.

Suppose a Ship in the Latitude of 33°, $40'$ North, sails between South and East 165 Miles, and has then made of Easting 112.5 Miles. Required the difference of Latitude, Course, and Difference of Longitude.

First, For the Course, it will be, by *Case* 5. *of Plain Sailing*,

As the Distance - -	165 - -	2.21748
is to Radius - - - -		10.00000
so is the Departure - -	102.5 - -	2.05115
to the Sine of the Course	42°, $59'$	9.83367

which because the Ship sails between South and East, will be South 42°, $59'$ East, or SE*b*S, $\frac{1}{4}$ East nearly.

And for the difference of Latitude it will be, by the same *Case*,

As Radius - - - - - -		10.00000
is to the Distance - -	165 - -	2.21748
so is the Co-sine of the Course	42°, $59'$	9.86436
to the Diff. of Latitude -	120.7 -	2.08184

equal to 2°, $00'$; consequently the Latitude come to will be 31°, $40'$ North, and the Latitude of the middle *Parallel* will be 32°, $40'$. Hence to find the difference of Longitude it will be, by *Case* 2. *of Parallel Sailing*,

As the Co-sine of the mid. *Par.*	32°, $40'$	9.92522
is to the Departure - - -	112.5 -	2.05115
so is Radius - - - - -		10.00000

to min. of Diff. of Long.	-	133.6	- 2.12593

equal to 2°, 13′ nearly, the difference of Longitude Easterly.

CASE 8.

Difference of Longitude and Departure given, to find Difference of Latitude, Course, and Distance sail'd.

Example.

Suppose a Ship in the Latitude of 50°, 46′ North, sails between South and West, till her Difference of Longitude is 3°, 12′, and is then found to have departed from her former Meridian 126 Miles. Required the difference of Latitude, Course, and Distance sail'd.

First, For the Latitude she has come to it will be, by *Case* 3. *of Parallel Sailing*,

As Min. of Diff. of Long.	-	192	- 2.28330
is to Departure	- - -	126	- 2.10037
so is Radius	- - - -		10.00000
to the Co-sine of the mid. *Par.*		48°, 59′	9.81707

Now since the middle Latitude is equal to half the Sum of the two Latitudes (by *Art.* 1. of this *Sect.*) and so the Sum of the two Latitudes equal to double the middle Latitude; it follows that if from double the middle Latitude we subtract any one of the Latitudes, the Remainder will be the other. Hence from twice 48°, 59′, *viz.* 97°, 58′ taking 50°, 46′ the Latitude sail'd from, there remains 47°, 12′, the Latitude come to. Consequently the difference of Latitude is 3°, 34′, or 214 Minutes.

Then

Then for the Course it will be, by *Case* 4. *of Plain Sailing*,

As diff. of Lat. - - - - -	214 - -	2.33041
is to Radius - - - - -		10.00000
so is the Departure - -	126 -	2.10037
to the Tang. of the Course -	30°, 29′	9.76996

which because it is between South and West, will be South 30°, 29′ West, or S S W ¼ West nearly.

And for the Distance it will be, by the same *Case*,

As Radius - - - - - -		10.00000
is to the diff. of Lat. -	214 -	2.33041
so is the Sec. of the Course -	30°, 29′	10.06461
to the Distance - - - -	248.4 -	2.39502

2. From what has been said, it will be easy to solve a Traverse, by the Rules of *Middle Latitude Sailing*.

Example.

Suppose a Ship in the Latitude of 43°, 25′ North, sails upon the following Courses, *viz.* S W *b* S 63 Miles, S S W ½ West 45 Miles, S *b* E 54 Miles, and S W *b* W 74 Miles. Required the Latitude the Ship has come to, and how far she has differ'd her Longitude.

First, By *Case* 2. of this *Sect.* find the difference of Latitude, and difference of Longitude belonging to each Course and Distance, and they will stand as in the following Table.

		Diff. of Lat.		*Diff. of Longit.*	
Course	*Dist.*	*N*	*S*	*E*	*W*
S W *b* S	63	———	52.4	———	47.85
S S W ½ W	45	———	39.7	———	28.62
S *b* E	54	———	53.0	13.75	———
S W *b* W	74	———	41.1	———	81.08
					15.755
	Diff. of Lat.		186.2		13.75
				Diff. of Long.	143.80

Hence it is plain the Ship has differ'd her Latitude 186.2 Minutes, or 3°, 06′, and so has come to the Latitude of 40°, 19′ North, and has made of difference of Longitude 143.8 Minutes, or 2°, 23′, 48″ Westerly.

3. This method of Sailing, tho' it be not strictly true, yet it comes very near the Truth, as will be evident, by comparing an Example wrought by this Method, with the same wrought by the Method deliver'd in the next *Section*, which is strictly true; and it serves without any considerable Error, in runnings of 450 Miles between the *Equator* and *Parallel* of 30 Degrees; of 300 Miles between that and the Parallel of 60 Degrees; and of 150 Miles, as far as there is any occasion, and consequently must be sufficiently exact for 24 Hours run.

SECT. X.

Of Mercator's Sailing.

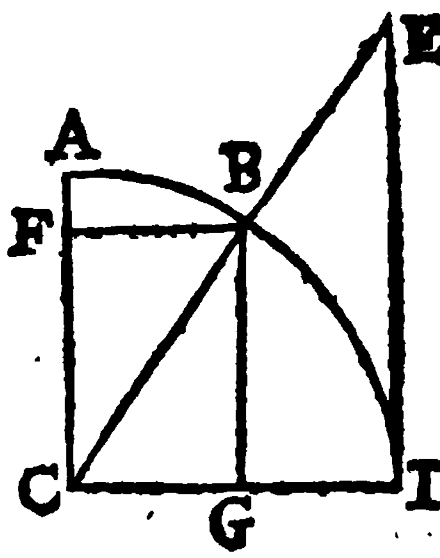
1. THO' the *Meridians* do all meet at the *Pole*, and the *Parallels* to the *Equator* do continually decrease, and that in proportion to the Cosines of their Latitudes; yet in old Sea *Charts* the

Meridians

Meridians were drawn parallel to one another, and consequently the *Parallels* of Latitude, made equal to the *Equator*, and so a Degree of Longitude on any *Parallel*, as large as a Degree on the *Equator*; also in these Charts the Degrees of Latitude were still represented (as they are in themselves) equal to each other and to those of the *Equator*. By these means Places were very erroneously mark'd down upon the Chart; thus, for instance, an Island on the *Parallel* of 60, would in this Chart be represented in a double Proportion, as to it's length in *Easting* and *Westing*, but the same as to its breadth in *Northing* and *Southing*; whereas in order to its being truly drawn upon the Chart, it ought to be lengthened, as to it's *Southing* and *Northing*, in the same Proportion as it is in it's *Easting* and *Westing*, so as the whole may be represented on the Chart proportionally as it is on the Globe itself.

2. To Remedy this Inconvenience, so as still to keep the *Meridians* parallel, 'tis plain we must protract, or lengthen, the Degrees of Latitude in the same proportion as those of Longitude are, that so the proportion in *Easting* and *Westing*, may be the same with that of *Southing* and *Northing*.

3. In the annex'd Scheme let ABD be a Quadrant of a Meridian, BF or CG the Radius of the Parallel describ'd by the Point B and CD the Radius of the Equator; draw the Tangent DE and Secant CE also the right Sine BG. Then it has been demonstrated, in *Sect.* 8. that a Degree upon any *Parallel*, is to a Degree on the *Equator*, as the Co-sine of it's Latitude, is to Radius.



Thus a Degree on the *Parallel* describ'd by the point B, is to a Degree on the *Equator*, as BF or CG is to CD the Radius; but (by *Art.* 74. *Sect.* 1.) CG : CD :: CB : CE; therefore a Degree

Degree on any *Parallel*, is to a Degree on the *Equator*, as Radius is to the Secant of the Latitude; and since in this Projection the *Meridians* are suppos'd to be parallel, and consequently each of the *Parallels* equal to the *Equator*, 'tis plain the Radius of any *Parallel* will become equal to the Radius of the *Equator*, and so CG will every where become equal to CD; but when CG becomes equal to CD, 'tis plain CB will become equal to CE. Consequently in this Projection, the Radius of the *Meridian* at any *Parallel*, will be equal to the Secant of the Latitude of that *Parallel*. Also since a Degree or any small Arch upon the *Equator*, is equal to a Degree or the like Arch upon the *Meridian*; therefore as the Secant of any *Parallel*, is to Radius, so is the length of a Degree or any small Arch on the *Meridian*, to the length of a Degree or like Arch on that *Parallel*. Hence 'tis evident that, in this Projection where the *Meridians* are parallel, a Degree on any *Parallel* will be increas'd beyond it's just proportion, at such rate as the Secant of the Latitude, is greater than Radius; and consequently the Degrees on the *Meridian* must every where be increas'd in the same Rate; that so the proportion in *Northing* and *Southing*, may be the same with that of *Easting* and *Westing*, that is, the length of a Degree or any small Arch on the inlarg'd *Meridian*, must every where be to a Degree or like Arch of the *Meridian* on the Globe, as the Secant of the Latitude, is to Radius. Hence by supposing the length of any small Arch of the *Meridian* Radius, it follows from what has been said,

Cor. 1. That the length of a Degree or any small Arch on the inlarg'd *Meridian*, is every where equal to the Secant of the Arch contain'd between it and the *Equator*.

2. The

2. The Diſtance of any Point upon the inlarg'd *Meridian* from the *Equator*, is equal to the Sum of all the Secants contain'd between it and the *Equator*.

3. The Diſtance between any two *Parallels* on the ſame ſide of the *Equator*, is equal to the difference of the Sums of all the Secants contain'd between the *Equator* and each of the *Parallels*.

4. The Diſtance between any two *Parallels* on contrary ſides of the *Equator*, is equal to the Sum of the Sums of all the Secants contain'd between the *Equator* and each *Parallel*.

4. Now ſince it has been ſhewn, that in this Projection the Diſtance of each point of the *Meridian* from the *Equator*, is equal to the Sum of all the Secants contain'd between it and the *Equator*; 'tis plain that by a continual Addition of the Secants, beginning at the *Equator*, we ſhall have the Diſtance of every particular Point in the *Meridian* from the *Equator*, which Diſtances collected together form the Table, commonly call'd *A Table of Meridional Parts*, which is annex'd to the End of this *Section*, and in which you may obſerve that the top Column contains, the Degrees, and the left-hand ſide Column the Minutes; the other Columns contain the meridional Parts anſwering to theſe Degrees and Minutes. There is alſo upon *Gunter's Scale*, a Line of meridional Parts, mark'd *Mer.* which ſhows the diſtance of each Point of the *Meridian* from the *Equator*.

5. By either of theſe, *viz.* the Table of meridional Parts, or the meridian Line upon *Gunter's* Scale, may a *Mercator's Chart* be conſtructed. Thus for Example, let it be required to make a Chart that ſhall commence at the *Equator*, and reach to the parallel of 60 Degrees, and ſhall contain 80 Degrees of Longitude.

Draw

Draw the Line E Q representing the *Equator*; (see *Plate* 1.) then take from any convenient Line of equal Parts, 4800 (the number of Minutes contain'd in 80 Degrees) which set off from E to Q, and this will determine the Breadth of the Chart.

Divide the Line E Q into eight equal parts, in the Points 10, 20, 30, &c. each containing 10 Degrees, and each of these divided into 10 equal parts will give the single Degrees upon the *Equator*; then thro' the points E, 10, 20, &c. drawing Lines perpendicular to E Q, these shall be Meridians.

From the scale of equal parts take 4527.4 (the meridional parts answering to 60 Degrees) and set that off from E to A and from Q to B, and join AB; then this Line will represent the Parallel of 60, and will determine the length of the Chart.

Again from the scale of equal parts take 603.1, (the meridional parts answering to 10 Degrees) and set that off from E to 10 on the line E A, and thro' the point 10 draw 10, 10, parallel to E Q, and this will be the *Parallel* of 10 Degrees. The same way setting off from E on the line E A, the meridional parts answering to each Degree, *&c.* of Latitude, and thro' the several points drawing lines parallel to E Q, we shall have the several *Parallels* of Latitude.

If the *Chart* does not commence from the Equator, but is only to serve for a certain distance on the *Meridian* between two given *Parallels* on the same side of the *Equator*; then the *Meridians* are to be drawn as in the last Example, and for the Parallels of Latitude you are to proceed thus; *viz.* from the meridional parts answering to each point of Latitude in your *Chart*, subtract the meridional parts answering to the least Latitude, and set off the differences severally, from the Parallel of least Latitude, upon the two extream Meridians, and the lines joining these points of the Meridians shall represent the several *Parallels* upon your *Chart*.

Thus

Thus let it be required to draw a *Chart* that shall serve from the Latitude of 20 Degrees North, to 60 Degrees North, and that shall contain 80 Degrees of Longitude.

Having drawn the Line DC to represent the Parallel of 20 Degrees (see *Plate* 1.) and the *Meridians* to it, as in the foregoing Example; set off 663.3 (the difference between the meridional Parts answering to 30 Degrees, and those of 20 Degrees) from D to 30, and from C to 30; then join the points 30 and 30 with a right Line, and that shall be the Parallel of 30. Also set off 1397.6 (the difference between the meridional Parts answering to 40 Degrees, and those of 20 Degrees (from D to 40, and from C to 40, and joining the points 40, and 40 with a right Line, that shall be the Parallel of 40. And proceeding after the same Way, we may draw as many of the intermediate Parallels as we shall have occasion for.

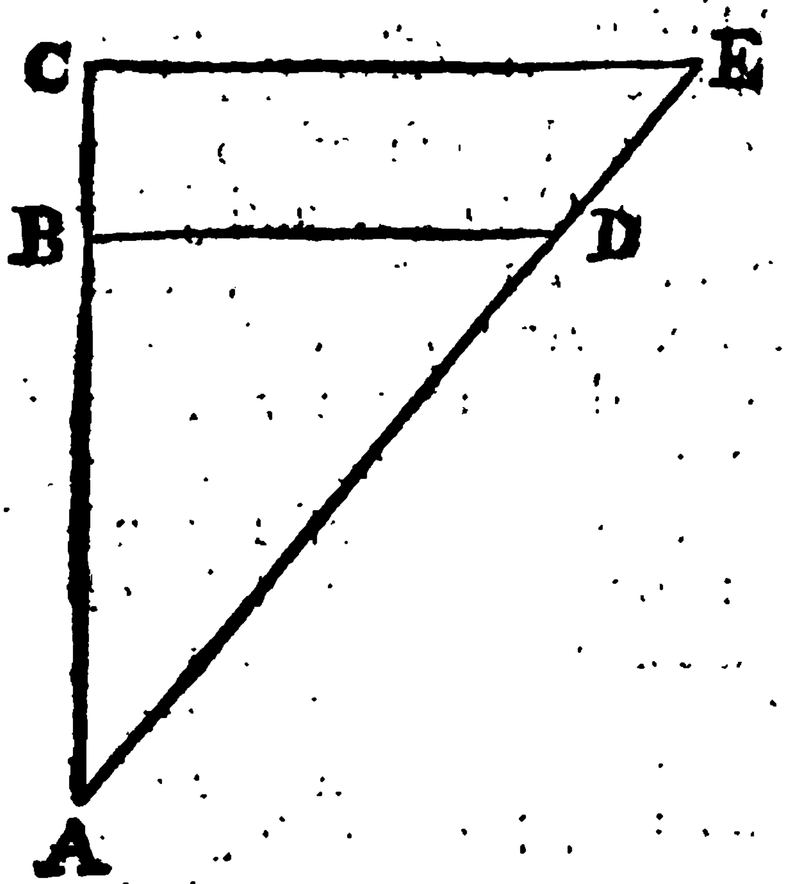
But if the two *Parallels* of Latitude that bounds the *Chart*, are on the contrary sides of the *Equator*; then draw a Line representing the *Equator*, and *Meridians* to it, as in the first *Example*; and from the *Equator* set off on each side of it the several Parallels contained between it and the given Parallels as above, and your *Chart* is finished.

N. B. Here you must notice; that in all *Charts*, the upper part is the *North* Side, and the lower part or bottom is the *South* Side; also that part of it towards the right Hand is the *East*, and that towards the left Hand the *West* Side of the *Chart*.

6. Since according to this Projection, the *Meridians* are parallel right Lines; 'tis plain, that the Rumbs which form always equal Angles with the *Meridians*, will be streight Lines; which Property renders this Projection of the Earth's surface much more easy and proper for Use, than any other.

7. This method of projecting the Earth's surface upon a Plain, was first invented by Mr. *Edward Wright*, but first published by *Mercator*; and hence the sailing by the *Chart*, was called *Mercator's* sailing.

8. In the annexed Scheme, let A and D represent two places upon the surface of the Globe, A C the Meridian of A; and A D the Rumb Line between the two places; thro' D draw D B perpendicular to A C, and this will be the *Parallel* of Latitude of the place D; from A set off upon the



Meridian, the length A C, equal to the *Meridional* or *inlarg'd Difference of Latitude*, and thro' C draw C E parallel B D meeting A D produced in E; then A B will be the *proper Difference of Latitude*, and A C the *inlarg'd Difference of Latitude*, or the Difference of Latitude according to *Mercator's Chart*, between the places A and D: C E will be the *Difference of Longitude*, and B D the *Departure*, also A D will be the *proper Distance*, and A E the inlarg'd, or according to *Mercator's Chart*, and the Angle B A D will be the *Course*.

9. Now

9. Now since in the Triangle ACE, BD is parallel to one of it's sides CE; 'tis plain the Triangles ACE, ABD will be similar, and consequently the sides proportional (by *Art.* 74. *Sect.* 1.) Hence arises the Solutions of the several *Cases* in this sailing, which are as follows.

CASE I.

The Latitudes of two Places given, to find the meridional or inlarg'd Difference of Latitude between them.

Of this *Case* there are three Varieties, *viz.* either one of the places lies on the *Equator*, or both on the same side of it; or lastly on different sides.

1. If one of the proposed places lies on the Equator, then the meridional difference of Latitude, is the same with the Latitude of the other place, taken from the Table of meridional Parts.

Example.

Required, the meridional difference of Latitude between *St. Thomas*, lying on the *Equator* and *St. Antonio* in the Latitude of 17°, 20′ North. I look in the following Table for the meridional Parts answering to 17°, 20′, and find it to be 1056.2, the inlarg'd difference of Latitude required.

2. If the two proposed places be on the same side of the *Equator*, then the meridional difference of Latitude is found by subtracting the meridional Parts answering to the least Latitude, from those answering to the greatest, and the difference is that required.

Example.

Required the meridional difference of Latitude between the *Lizard* in the Latitude of 50°, 00′ North, and *Antegoa*, in the Latitude of 17°, 30′ North.

From the meridional parts of - -	50°, 00′	-	3474.5
ſubtract the merid. parts of -	17°, 30′	-	1066.7
there remains - - - - - - - - - -			2407.8

the meridional difference of Latitude required.

3. If the places lie on different ſides of the *Equator*, then the meridional difference of Latitude is found by adding together the meridional parts anſwering to each Latitude, and the Sum is that required.

Example.

Required the meridional difference of Latitude between *Antegoa*, in the Latitude of 17°, 30′ North, and *Lima*, in *Peru*, in the Latitude of 12°, 30′ South.

To the merid. parts anſwering to	17°, 30′	-	1066.7
add theſe anſwering to - -	12 , 30	-	756.1
the Sum is - - - - - - - - - - -			1822.8

the meridional difference of Latitude required.

CASE 2.

The Latitudes, and Longitudes of two Places given, to find the direct Courſe and Diſtance between them.

Example.

Example.

Required to find the direct Courſe and Diſtance between the *Lizard*, in the Latitude of 50°, 00′ North, and *Port-Royal in Jamaica*, in the Latitude of 17°, 40′; differing in Longitude 70°, 46′, *Port-Royal* lying ſo far to the Weſtward of the *Lizard*.

Preparation.

From the Latitude of the *Lizard*	- -	50°, 00′
ſubtract the Lat. of *Port-Royal*	- -	17 , 40
and there remains	- - - -	32 , 20

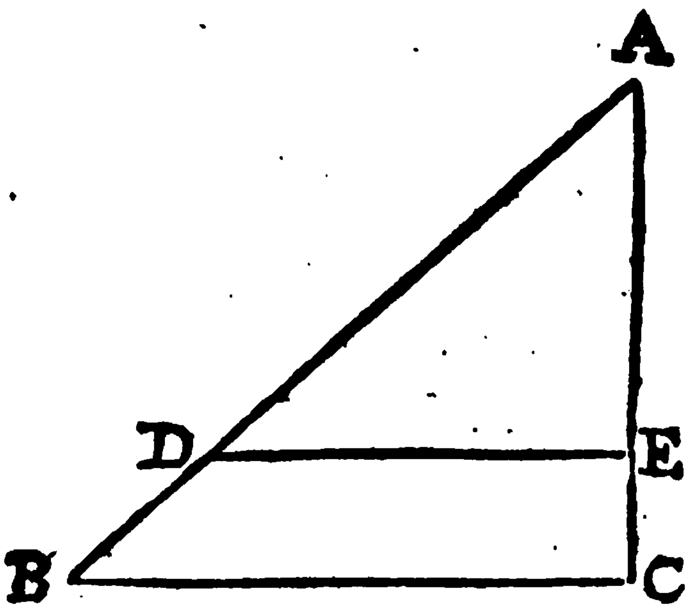
equal to 1940 Minutes, the proper difference of Latitude,

Then from the merid. parts of 50°, 00′	-	3474.5
ſubtract thoſe of - - - 17 , 40	-	1077.2
and there remaims - - - - - - -	-	2397.3

the meridional or inlarg'd difference of Latitude.

Geometrically.

Draw the Line A C repreſenting the *Meridian* of



the *Lizard* at A, and ſet off from A, upon that Line,

Line, AE equal to 1940 (from any scale of equal parts) the proper difference of Latitude, also AC equal to 2397.3 (from the same scale) the meridional or inlarg'd difference of Latitude. Upon the point C raise CB perpendicular to AC, and make CB equal to 4246 the Minutes of difference of Longitude.

Join AB, and thro' E draw ED parallel to BC; so the Case is constructed, and AD applied to the same scale of equal parts the other Legs were taken from, will give the direct Distance, and the Angle DAE measured by the line of Chords will give the Course.

By Calculation.

For the Angle of the Course EAD it will be, by *Case 4. of Rectangular Trigonometry.*

AC : CB : : R : T, BAC. *i. e.*

As the meridional diff. of Lat. - -	2397.3 -	3.37970
is to the Diff. of Long. - - -	4246.0 -	3.62798
so is Radius - - - - - -		10.00000
to the Tang. of the direct Course	60°, 33′	10.34828

which because *Port-Royal* is Southward of the *Lizard*, and the difference of Longitude Westerly, will be South 60°, 33′ West, or S W *b* W ½ West nearly.

Then for the Distance AD, it will be, by *Case 2. of Rectangular Trigonometry.*

R : AE : : Sec. A : AD. *i e.*

As the Radius - - - - - - - -		10.00000
so is the proper diff. of Lat.	1940 -	3.28780
so is the Sec. of the Course -	60°, 33′	10.30833

to

to the Distance - - - - - 3945.6 - 3.59613

consequently the direct Course and Distance between the *Lizard*, and *Port-Royal* in *Jamaica*, is South 60°, 33' West, 3945.6 Miles.

CASE 3.

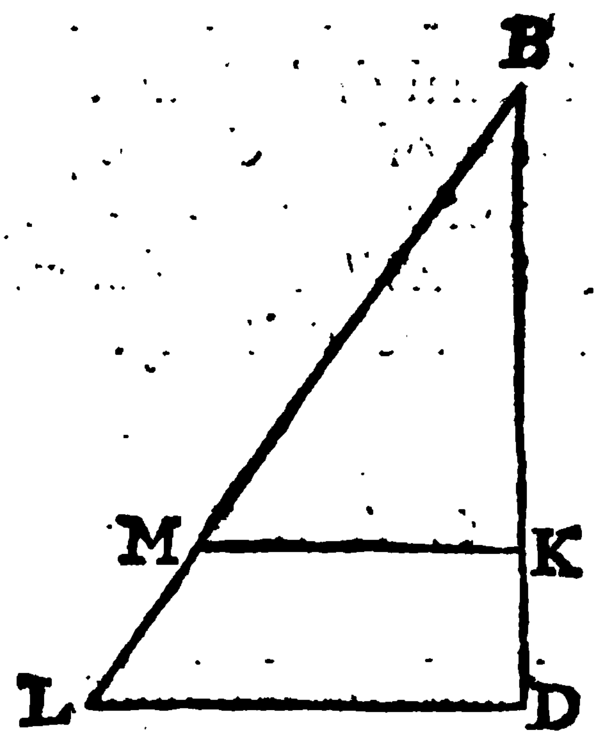
Course and Distance sail'd given, to find Difference of Latitude and Difference of Longitude.

Example.

Suppose a Ship from the *Lizard* in the Latitude of 50°, 00' North, sails South 35°, 40' West 156 Miles. Required the Latitude come to, and how much she has alter'd her Longitude.

Geometrically.

1. Draw the line B K representing the Meridian of the *Lizard* at B; from B draw the line B M,



making with B K an Angle equal to 35°, 40', and upon this line set off B M equal to 156 the given Distance,

Distance, and from M let fall the perpendicular MK upon BK.

Then for BK the proper difference of Latitude, it will be, by *Case* 3. *of Rectangular Trigonometry.*

R : MB :: S, BMK : BK.

i. e. As Radius - - - - - - - -		10.00000
is to the Distance - -	156 -	2.19312
so is the Co-sine of the Course	35°, 40′	9.90978
to the proper diff. of Lat. -	127 -	2.10290

equal to 2°, 07′, and since the Ship is sailing from a North Latitude towards the South, therefore the Latitude come to will be 47°, 53′ North. Hence the meridional difference of Latitude will be 193.4.

2. Produce BK to D, till BD be equal to 193.4; thro' D draw DL parallel to MK, meeting DM produced in L; then DL will be the difference of Longitude: to find which by Calculation; it will be, by *Case* 1. *of Rectangular Trigonometry.*

R : BD :: T, LBD : DL.

i. e. As Radius - - - - - - -		10.00000
is to the meridional diff. of Lat.	193.4 -	2.28646
so is the Tangent of the Course	35°, 40′	9.85594
to Min. of Diff. of Long. - -	138.8	2.14240

equal to 2°, 18′, 48″ the difference of Longitude the Ship has made Westerly.

CASE 4.

Given, Course and both Latitudes, viz. *the Latitude sail'd from, and the Latitude come to, to find the Distance sail'd and the Difference of Longitude.*

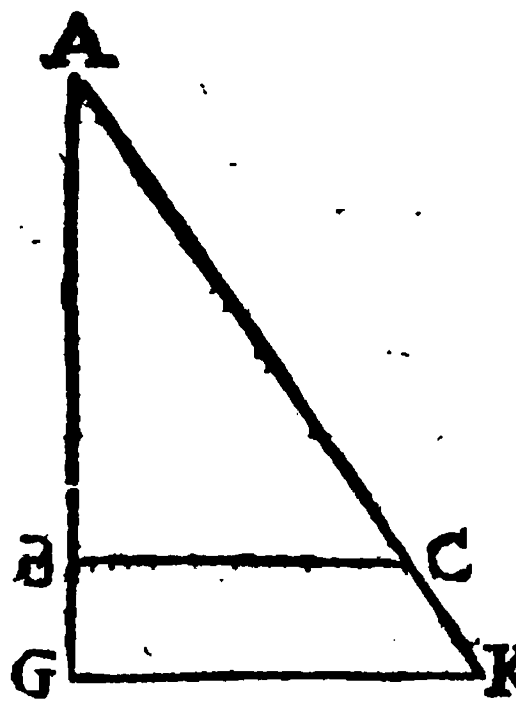
Example.

Example.

Suppose a Ship in the Latitude of 54°, 20′ North, sails South 33°, 45′ East, until by Observation she's found to be in the Latitude of 51°, 45′ North. Required the Distance sail'd, and the difference of Longitude.

Geometrically.

Draw AB, to represent the Meridian of the Ship in the first Latitude, and set off from A to B 155, the Minutes of the proper difference of Latitude, also AG equal to 257.9 the Minutes of the enlarg'd Difference of Latitude. Thro' B and G draw the Lines BC and GK perpendicular to AG; also draw AK making with AG an Angle of 33° 45′ which will meet the two former Lines in the points C and K; so the Case is constructed, and AC and GK may be found from the line of equal parts, to find which



By Calculation.

First, For the difference of Longitude it will be, by *Case* 1. *of Rectangular Trigonometry.*

R : AG : : T, GAK : GK.

i. e. As Radius - - - - - - - -		10.00000
is to the inlarg'd diff. of Lat. -	257.9 -	2.41145

 so

so is the Tang. of the Course	$33°$ $45'$	-	9.82489
to min. of Diff. of Longit.	- 172.3	-	2.23634

equal to 2°, 52′, 18″, the difference of Longitude the Ship has made Easterly.

This might also have been found, by first finding the Departure B C (by *Case* 2. *of Plain Sailing*) and then (by *Art.* 74. *Sect.* 1.) it would be

AB : BC : : AG : GK. The difference of Longitude required.

Then for the direct Distance AC, it will be, by *Case* 2. *of Rectangular Trigonometry.*

R : AB : : Sec. A : A C.

i. e. As Radius	- - - - -		10.00000
is to the proper Diff. of Lat.	-	155 -	2.19033
so is the Secant of the Course		33°, 45′	10.08015
to the direct Distance	- -	186.4 -	2.27048

consequently the Ship has sail'd South 33°, 45′ East, 186.4 Miles, and has differ'd her Longitude 2°, 52′, 18″ Easterly.

CASE 5.

Both Latitudes, and Distance sail'd, given, to find the direct Course, and Difference of Longitude.

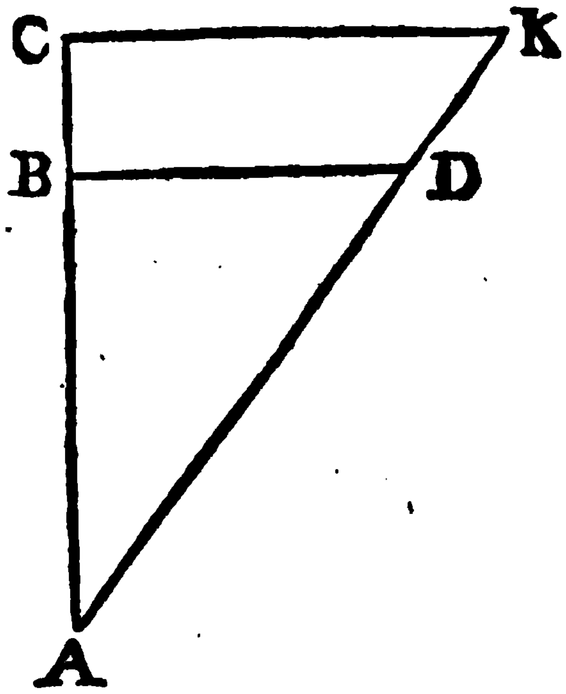
Example.

Suppose a Ship from the Latitude of 45°, 26′ North, sails between North and East 195 Miles, and then by Observation she's found to be in the Latitude of 48°, 06′ North. Required the direct Course and difference of Longitude.

Geometrically.

Geometrically.

Draw AB equal to 160 the proper difference of Latitude, and from the point B raiſe the perpendicular BD; then take 195 in your Compaſſes and ſetting one foot of them in A, with the other croſs the line BD in D. Produce AB till AC be equal to 233.6 the inlarg'd difference of Latitude. Thro' C draw CK parallel to BD, meeting AD produc'd in K; ſo the Caſe is conſtructed, and the Angle A may be meaſured by the line of Chords, and CK by the line of equal parts. To find which



By Calculation.

Firſt, For the Angle of the Courſe BAD it will be, (by *Caſe* 5, *of Rectangular Trigonometry*.)

AB : R :: AD : Sec. A. *i. e.*

As the proper Diff. of Lat.	160 - -	2.20412
is to Radius - - - - - - - - - -		10.00000
ſo is the Diſtance - -	195 - -	2.29003
to the Sec. of the Courſe	34°, 52′ -	10.08591

which becauſe the Ship is ſailing between North Eaſt, will be North 34°, 52′ Eaſt, or SE*b*S 1°, 07′ Eaſterly.

Then for the difference of Longitude it will be, (by *Caſe* 1. *of Rectangular Trigonometry*.)

R : AC : : T, A : CK.

i. e. As Radius	- - - - - - - - - -		10.00000
is to the merid. diff. of Lat.	-	233.6	- 2.36847
so is the Tang. of the Course		34°, 52′	9.84307
to min. of diff. of Long.	-	162.8	- 2.21154

equal to 2°, 42′, 48″, the difference of Longitude Easterly.

CASE 6.

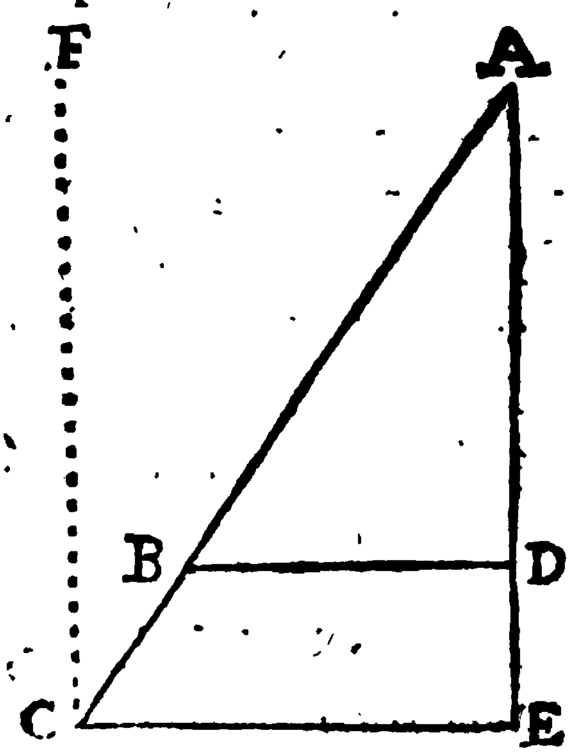
One Latitude, Course, and Difference of Longitude, given, to find the other Latitude, and Distance sail'd.

Example.

Suppose a Ship from the Latitude of 48°, 50′ North, sails South 34°, 40′ West, till her difference of Longitude is 2°, 44′. Required the Latitude come to, and the Distance sail'd.

Geometrically.

1. Draw AE to represent the Meridian of the Ship in the first Latitude, and make the Angle



EAC equal to 34°, 40′, the Angle of the Course; then draw FC parallel to AE, at the distance of 164 the Minutes of difference of Longitude, which will meet AC in the point C. From C let fall upon AE the perpendicular CE; then AE will be the inlarg'd difference of Latitude. To find which, by *Calculation* it will be, by *Case* 1. of *Rectangular Trigonometry*,

T,

T, A : R : : CE : AE.

i. e. As the Tang. of the Course	34°, 40′	9.83984
is to the Radius		10.00000
so is min. of diff. Long.	164	2.21484
to the inlarg'd diff. of Lat.	237.2	2.37500

and because the Ship is sailing from a North Latitude Southerly. Therefore,

From the merid. parts of the Latitude sail'd from	48°, 50′	3366.9
take the merid. diff. of Lat.		237.2
and there remains		3129.7

the meridional parts of the Latitude come to, *viz.* 46°, 09′.

Hence for the proper difference of Latitude,

From the Latitude sail'd from	48°, 50′ N
take the Latitude come to	46 , 09 N
and the remains	2 , 41

equal to 161, the Minutes of difference of Latitude.

2. Set off upon AE the length AD equal to 161 the proper difference of Latitude, and thro' D draw DB parallel to CE; then AB will be the direct Distance. To find which, *by Calculation* it will be, by *Case 2. of Rectangular Trigonometry*,

R : AD : : Sec. A : AB.

i. e. As Radius		10.00000
is to the proper diff. of Lat.	161	2.20683
so is the Sec. of the Course	34°, 40′	10.08488
to the direct Distance	195.8	2.29171

CASE 7.

CASE 7.

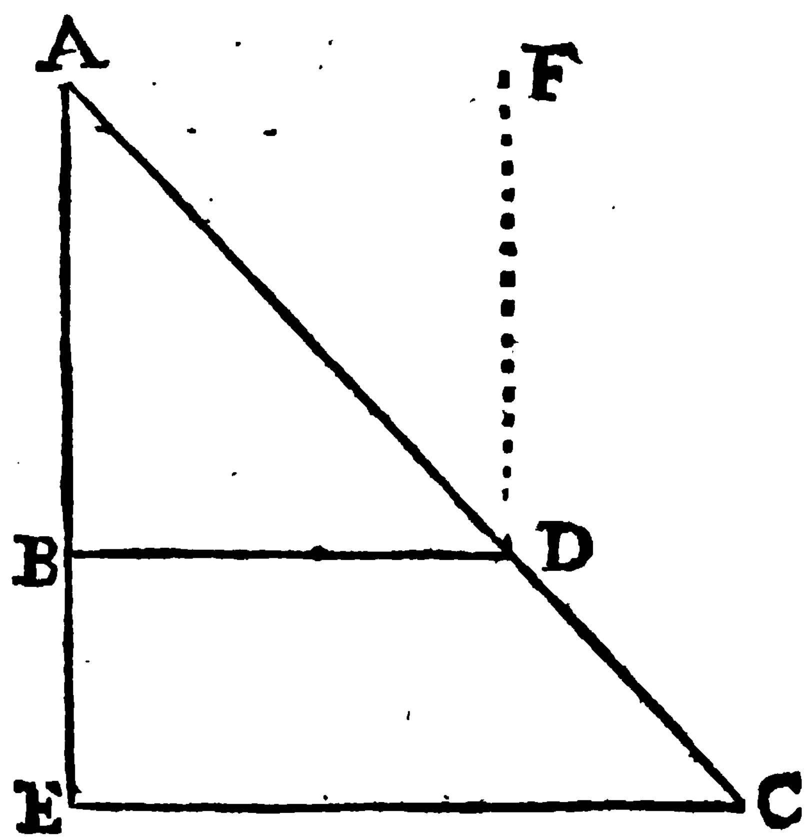
One Latitude, Course and Departure given, to find the other Latitude, Distance sail'd and Difference of Longitude.

Example.

Suppose a Ship sails from the Latitude of 54°, 36′ North, South 42°, 33′ East, until she has made of Departure 116 Miles. Required the Latitude she is in, her direct Distance sail'd, and how much she has alter'd her Longitude.

Geometrically.

1. Having drawn the Meridian AB, make the Angle BAD equal to 42°, 33′. Draw FD pa-



rallel to AB at the Distance of 116, which will meet AD in D. Let fall upon AB the perpendicular DB. Then AB will be the proper difference

rence of Latitude, and AD the direct Distance, to find which, *by Calculation*; first, for the Distance AD it will be, by *Case* 2. *of Rectangular Trigonometry*.

S, A : BD : : R : AD.

i. e. As the Sine of the Course		42°, 33′	9.83010
is to the Departure	- -	116 -	2.06446
so is Radius	- - - - -		10.00000
to the direct Distance	- -	171.5 -	2.23436

Then for the proper difference of Latitude it will be, by *Case* 1. *of Rectangular Trigonometry*,

T, A : BD : : R : AB.

i. e. As the Tang. of the Course		42°, 33′	9.96281
is to the Departure	- - -	116 -	2.06446
so is Radius	- - - - - - - - -		10.00000
to the proper diff. of Lat	-	126.4 -	2.10165

equal to 2°, 6′, consequently the Ship has come to the Latitude of 52°, 30′ North, and so the meridional difference of Latitude will be 212.2.

2. Produce AB to E, till AE be equal to 212.2; and thro' E draw EC parallel to BD, meeting AD produc'd in C; Then EC will be the difference of Longitude, to find which, *by Calculation* it will be, by *Case* 1. *of Rectangular Trigonometry*,

R : AE : : T, A : EC.

i. e. As Radius	- - - - - -		10.00000
is to the merid. diff. of Lat.	-	212.2 -	2.32675
so is the Tang. of the Course		42°, 33′	9.96281
to the min. of diff. of Long.	-	194.8 -	2.28956

equal to 3°, 14′, 48″, the difference of Longitude Easterly.

This

This might have been found otherwise; thus, because the Triangles ACE, ADB are similar, therefore (by *Art.* 74. *Sect.* 1.) it will be

AB : BD : : AE : EC.

i. e. As the proper diff. of Lat.	-	126.4	- 2.10165
is to the Departure	- - -	116	- 2.06446
so is the inlarg'd diff. of Lat.	-	212.2	- 2.32675
to min. diff of Long.	- - -	194.8	- 2.28956

CASE 8.

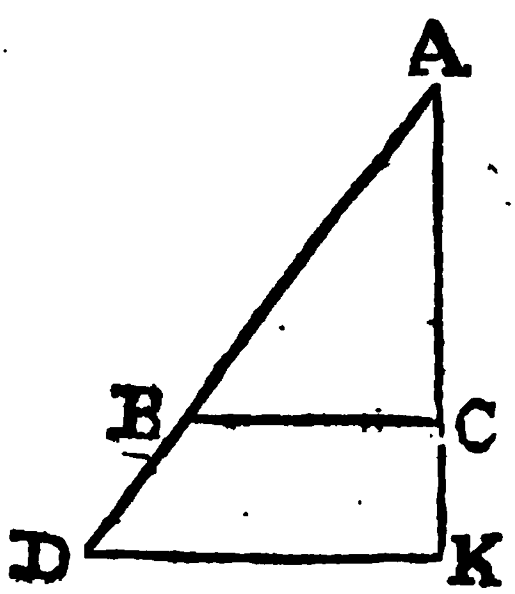
Both Latitudes and Departure given, to find Course, Distance and Difference of Longitude.

Example.

Suppose a Ship from the Latitude of 46°, 20′ North, sails between South and West, till she has made of Departure 126.4 Miles; and is then found by Observation to be in the Latitude of 43°, 35′ North. Required the Course and Distance sail'd, and difference of Longitude.

Geometrically.

Draw AK to represent the Meridian of the Ship in her first Latitude, set off upon it AC, equal to 165, the proper difference of Latitude. Draw BC perpendicular to AC, equal to 126.4 the Departure, and join AB. Set off from A, AK equal to 233.3, the inlarg'd difference of Latitude, and thro' K draw KD parallel to BC, meeting AB produc'd in D; so the *Case* is constructed,



structed, and DK will be the difference of Longitude, AB the Distance, and the Angle A the Course; to find which

By Calculation.

First, For DK the difference of Longitude, it will be (by *Art.* 74. *Sect.* 1.)

AC : CB :: AK : KD.

i. e. As the proper diff. of Lat.	165	-	2.21748
is to the Departure - - - -	126.4	-	2.10175
so is the inlarg'd diff. of Lat. -	233.3	-	2.36791
to min. of diff. of Long. - - -	178.7	-	2.25218

equal to 2°, 58′, 42″, the difference of Longitude Westerly.

Then for the Course it will be, (by *Case* 4. *of Rectangular Trigonometry*,)

AC : BC :: R : T, A.

i. e. As the proper diff. of Lat.	165	- -	2.21748
is to Departure - - - -	126.4	-	2.10175
so is Radius - - - - - -			10.00000
to the Tang. of the Course -	37°, 27′	-	9.88427

which because the Ship sails between South and West, will be South 37°, 27′ West, or SW*b*S 6°, 30′ Westerly.

Lastly, For the Distance AB, it will be, (by *Case* 2. *of Rectangular Trigonometry*,)

S, A : BC :: R : AB.

i. e. As the Sine of the Course	37° 27′	-	9.78395
is to the Departure	- -	126.4	2.10175
so is Radius	- - - -		10.00000
to the direct Distance	- -	207.9	2.31780

CASE 9.

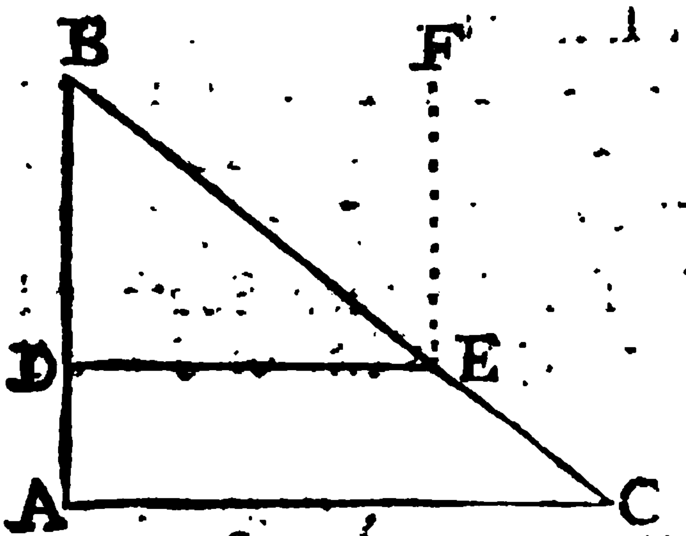
One Latitude, Distance sail'd, and Departure given, to find the other Latitude, Difference of Longitude and Course.

Example.

Suppose a Ship in the Latitude of 48°, 33′ North, sails between South and East 138 Miles, and has then made of Departure 112.6. Required the Latitude come to, the direct Course and difference of Longitude.

Geometrically.

1. Draw BD for the Meridian of the Ship at B, and parallel to it draw FE, at the Distance of 112.6, the Departure. Take 138, the distance, in your Compasses, and fixing one point of them in B, with the other cross the line FE in the point E; then join B and E, and from E let fall upon BD the perpendicular ED; so BD will be the proper difference fo Latitude, and the Angle B, will be the Course; to find which, *by Calculation.*



First,

First, For the Course it will be, (by *Case* 5. *of Rectangular Trigonometry.*)

BE : R :: DE : S, B.

i. e. As the Distance - - -	138 -	2.13988
is to Radius - - - -		10.00000
so is the Departure -	112.6 -	2.05154
to the Sine of the Course -	54°, 41′	9.91166

which because the Ship sails between South and East, will be South 54°, 41′ East, or SE 9°, 41′ Easterly.

Then for the difference of Latitude it will be, (by *Case* 3. *of Rectangular Trigonometry.*)

R : BE :: Co-S, B : BD.

i. e. As Radius - - - - -		10.00000
is to the Distance - - - -	138 - -	2.13988
so is the Co-sine of the Course	54°, 41′	9.76200
to the diff. of Lat. - - - -	79.8 -	1.90188

equal to 1°, 19′. Consequently the Ship has come to the Latitude of 47°, 13′. Hence the meridional difference of Latitude will be 117.7.

2. Produce B to A, till BA be equal to 117.7, and thro' A draw AC parallel to DE, meeting BE produc'd in C; then AC will be the difference of Longitude, to find which, *by Calculation* it will be (by *Art.* 74. *Sect.* 1.)

BD : DE :: BA : AC.

i. e. As the proper diff. of Lat.	79.8 -	1.90188
is to the Departure - -	112.6 -	2.05154
so is the inlarg'd diff. of Lat.	117.7 -	2.07078

 to

to the diff. of Long. - - 166.1 - - 2.22044
equal to 2°, 46′, 06″, the difference of Longitude Easterly.

9. From what has been said, it will be easy to solve a *Traverse* according to the Rules of *Mercator's-Sailing*.

Example.

Suppose a Ship at the *Lizard* in the Latitude of 50°, 00′ North, is bound to the *Madera*, in the Latitude of 32°, 20′ North, the difference of Longitude between them, being 11°, 40′ the West end of the *Madera*, lying so much to the Westward of the *Lizard*, and consequently the direct Course and Distance (by *Case* 2. of this *Sect.*) is South 26°, 15′ West 1181.9 Miles; but by reason of the Winds she is forced to sail on the following Courses (allowance being made for Leeway and Variation, *&c.*) *viz.* SSW 44 Miles, S*b*W ½ West 36 Miles, SW*b*S 56 Miles, and S*b*E 28 Miles. Required the Latitude the Ship is in, her Bearing and Distance from the *Lizard*, and her direct Course and Distance from the *Madera*, at the end of these Courses.

The *Geometrical Construction* of this *Traverse*, is perform'd by laying down the two Ports according to Construction of *Case* 2. of this *Sect.* and the several Courses and Distances according to *Case* 3. by which we have the following Solution *by Calculation.*

1. Course SSW, Distance 44 Miles.
For Difference of Latitude

As Radius - - - - - - - -		10.00000
is to the Distance - - - -	44 - -	1.64345

So

so is the Co-sine of the Course 22°, 30′ - 9.96562
to the diff. of Lat. - - - 40.65 - 1.60907

and since the Course is Southerly, therefore the Latitude come to will be 49°, 20′ North, and consequently the meridional difference of Latitude will be 61.8. Then

For Difference of Longitude.

As Radius - - - - - - - - - - -		10.00000
is to the inlarg'd diff. of Lat.	61.8 -	1.79099
so is the Tang. of the Course	22°, 30′	9.61722
to min. of diff. of Long. - -	25.6 -	1.40821

2. Course S *b* W ½ West, Distance 36 Miles.
For Difference of Latitude.

As Radius - - - - - - - - - - -		10.00000
is to the Distance - - -	36 - -	1.55630
so is the Co-sine of the Course	16°, 52′ -	9.98090
to the diff. of Latitude - -	34.46 -	1.53720

and since the Course is Southerly, therefore the Latitude come to will be 48°, 45′. Hence the meridional difference of Latitude will be 53.4 Then,

For the Difference of Longitude.

As Radius - - - - - -		10.00000
is to the inlarg'd diff. of Lat.	53.4 -	1.72754
so is the Tang. of the Course	16°, 52′ -	9.48171
to the diff. of Long. - -	16.19 -	1.20925

3. Course S W *b* S, Distance 56 Miles.
For Difference of Latitude.

As

As Radius - - - - -		10.00000
is to the Distance - -	56 -	1.74819
so is the Co-sine of the Course	33°, 45′	9.91985
to the diff. of Lat. - - - -	46.56 -	1.66804

consequently the Latitude come to is 47°, 59′ and therefore the inlarg'd difference of Latitude will be 69.2. Then

For Difference of Longitude.

As Radius - - - - -		10.00000
is to the inlarg'd diff. of Lat.	69.2 - -	1.84011
so is the Tang. of the Course	33°, 45′ -	9.82489
to the diff. of Long. - - -	46.24 -	1.66500

4. Course S *b* E, Distance 28 Miles.
For Difference of Latitude.

As Radius - - - - - -		10.00000
is to the Distance - - -	28 - -	1.44716
so is the Co-sine of the Course	11°, 15′ -	9.99157
to the diff. of Lat. - - - -	27.46 -	1.43873

consequently the Latitude come to will be 47°, 31′, and hence the meridional difference of Latitude will be 43.2. Then

For difference of Longitude.

As Radius - - - - -		10.00000
is to the inlarg'd diff. of Lat.	43.2 -	1.63548
so is the Tang. of the Course	11°, 15′	9.29866
to the diff. of Long. - -	8.59 -	0.93414

Now these several Courses and Distances together with the difference of Latitude and Longitude belong to each of them, being set down in their proper Columns in the *Traverse Table*, will stand as follows.

Course

		Diff. of Lat.		*Diff. of Longit.*	
Course	*Dist.*	*N*	*S*	*E*	*W*
S S W	44	——	40.65	——	25.6
S *b* W ½ W	36	——	34.46	——	16.19
S W *b* S	56	——	46.56	——	46.24
S *b* E	28	——	27.46	8.59	——
	Diff. of Lat.		149.13	8.59	88.03
					8.59
				Diff. of Long.	79.44

Hence it is plain that the Ship has made of Southing 149.13 Minutes, and consequently has come to the Latitude of 47°, 31′ North, and so the meridional difference of Latitude between that and her first Latitude will be 226.1; and since she has made of difference of Longitude 79.44 Minutes Westerly; therefore for the direct Course and Distance between the *Lizard* and the Ship, it will be, (by *Case* 2. *of this Section*)

For the direct Course.

As the merid. diff. of Lat.	226.1	2.35430
is to Radius		10.00000
so is the diff. of Long.	79.44	1.90004
to the Tang. of the Course	19°, 22′	9.54574

which because the difference of Latitude is Southerly, and the difference of Longitude Westerly, will be South 19°, 22′ West, or S *b* W 8°, 07′ Westerly. Then

For the direct Distance.

As Radius		10.00000
is to the proper diff. of Lat.	149.13	2.17349
so is the Sec. of the Course	19°, 22′	10.02530
to the direct Distance	158	2.19879

From

From the Latitude the Ship is in -	$47^\circ, 31'$	N
subtract the Lat. of the *Madera* -	$32\ ,\ 20$	N
and there remaims - - - -	$15\ ,\ 11$	

equal to 911 Minutes, the proper difference of Latitude between the Ship and the *Madera*.

Again from the merid. parts answering to the Lat. the Ship is in -	- 3248.4
Take the meridional parts answering to the Latitude of the *Madera* -	- 2052.0
and there remains - - - - - - - -	1196.4

the inlarg'd difference of Latitude between the Ship and the *Madera*.

Also, From the diff. of Long. between the *Liz.* and the *Madera*	$11^\circ, 40'$ W
Take the difference of Long. between the *Lizard* and the Ship	$1\ ,\ 19\ \frac{44}{100}$ W
and there remains - - - - -	$10\ ,\ 20\ \frac{56}{100}$ W

equal to 620.56 Minutes of difference of Longitude between the Ship and the *Madera* Westerly.

Then for the direct Course and Distance between the Ship and the *Madera*, it will be

For the direct Course.

As the merid. diff. of Lat.	1196.4	-	3.07788
is to Radius - - - - - - - - -		-	10.00000
so is the diff. of Long. -	620.56	-	2.79278
to the Tang. of the Course	$27^\circ, 25'$	-	9.71490

For the direct Distance.

As Radius - - - - - - -		-	10.00000
is to the proper diff. of Lat.	911	-	2.95952

so

so is the Sec. of the Course - 27°, 25′ - 10.05174
to the direct Distance - - 1027 - 3.01126

10. It is very common in working a Day's Reckoning at Sea, to find the Difference of Latitude and Departure to each Course and Distance, and adding all the Departures together, and all the Differences of Latitudes for the whole Departure and difference Latitude made good that Day; from thence (by *Case* 8. of this *Section*) to find the difference of Longitude, *&c.* made good that Day. Now that this method is false, will evidently appear, if we consider that the same Departure reckon'd on two different Parallels will give unequal differences of Longitude; and consequently when several Departures are compounded together and reckon'd on the same Parallel, the difference of Longitude resulting from that, cannot be the same with the sum of the differences of Longitude resulting from the several Departures on different Parallels; and therefore, I have chosen in the last *Example* of a *Traverse*, to find the difference of Longitude answering to each particular Course and Distance, the sum of which must be the true difference of Longitude made good by the Ship on these several Courses and Distances.

11. We shew'd at *Art.* 5. of this *Section*, how to construct a *Mercator's Chart*, and now we shall proceed to its several Uses, contain'd in the following *Problems*.

Prob. 1. Let it be required to lay down a place upon the *Chart*, its Latitude, and the difference of Longitude between it, and some known place upon the *Chart* being given.

Example. Let the known place be the *Lizard*, lying on the Parallel of 50°, 00′ North, and the place to be laid down *St. Katherines*, on the east Coast of *America*, differing in Longitude from the *Lizard* 42°, 36′, lying so much to the Westward of it.

Let L represent the *Lizard* on the *Chart*, (see *Plate* 1.) lying on the Parallel of 50°, 00′ North; its Meridian A E. Set off from E upon the Equator E Q 42°, 36′, towards Q, which will reach from E to F. Thro' F draw the Meridian F G, and this will be the Meridian of *St. Katherines*; then set off from Q to H upon the graduated Meridian Q B, 28 Degrees; and thro' H draw the parallel of Latitude H M, which will meet the former Meridian in K the place upon the *Chart* required.

Prob. 2. Given two places upon the *Chart*, to find their difference of Latitude and difference of Longitude.

Thro' the two places draw parallels of Latitude; then the Distance between these parallels number'd in Degrees and Minutes upon the graduated Meridian, will be the difference of Latitude required; and thro' the two places drawing Meridians, the distance between these counted in Degrees and Minutes on the Equator, or any graduated parallel, will be the difference of Longitude required.

Prob. 3. To find the bearing of one place from another upon the *Chart*.

Example. Required the bearing of *St. Katherines* at K, (see *Plate* 1.) from the *Lizard* at L.

Draw the Meridian of the *Lizard* A E, and join K and L with the right line K L, then by the line of Chords measuring the Angle K L E, and with that entering the Table at *Page* 156, we shall have the thing required.

This may also be done, by having Compasses drawn on the *Chart* (suppose at two of its Corners) then lay the edge of a Ruler over the two places and let fall a perpendicular, or take the nearest distance, from the center of the Compass next the first place, to the Rulers edge; then with this distance in your Compasses slide them along by the Ruler's edge, keeping one foot of them close to the

the Ruler, and the other as near as you can judge perpendicular to it, which will describe the Rumb required.

Prob. II. To find the Distance between two given places upon the *Chart.*

This *Problem* admits of four *Cases*, according to the situation of the two places, with respect to one another.

Case I. When the given places lie both upon the Equator.

In this *Case* their Distance is found by converting the Degrees of difference of Longitude intercepted between them into Minutes.

Case II. When the two places lie both on the same Meridian.

Draw the Parallels of those places, and the Degrees upon the graduated Meridian, intercepted between those Parallels, reduced to Minutes, give the Distance required.

Case III. When the two places lie on the same Parallel.

Example. Required to find the Distance between the points K and N, (see *Plate* 4.) both lying on the Parallel of 28°, 00′ North. Take from your scale the Chord of 60°, or Radius in your Compasses, and with that extent on KN as a Base, make the *Isosceles* Triangle KPN; then take from the line of Sines the Co-sine of the Latitude, or Sine of 60°, and set that off from P to S and T. Join S and T with the right line ST, and that applied to the graduated Equator will give the Degrees and Minutes upon it equal to the Distance; which, converted into Minutes, will be the Distance required.

The Reason of this is evident from *Sect.* 8. for it has been there demonstrated, that Radius is to the Co-sine of any Parallel, as the length of any Arch on the Equator, to the length of the same Arch on

that Parallel: now in this *Chart* KN is the Distance of the Meridians of the two places K and N upon the Equator, and since in the Triangle PNK, ST is parallel to KN, therefore PN : PT :: NK : TS. Consequently TS will be the Distance of the two places K and N upon the Parallel of 28°.

If the Parallel the two places lies on be not far from the Equator, and they not far asunder, then their Distance may be found thus. Take the Distance between them in your Compasses, and apply that to the graduated Meridian, so as the one foot may be as many Minutes above, as the other is below the given Parallel, and the Degrees and Minutes intercepted, reduced to Minutes, will give the Distance.

Or it may also be found thus. Take the length of a Degree on the Meridian at the given Parallel, and turn that over on the Parallel from the one place to the other, as oft as you can; then as oft as that extent is contain'd between the places, so many times 60 Miles will be contain'd in the Distance between them.

Case 4. When the places differ both in Longitude and Latitude.

Example. Suppose it were required to find the Distance between the two places *a* and *e* upon the *Chart*. By,

Prob. 2. Find the difference of Latitude between them, and take that in your Compasses from the graduated Equator, which set off on the Meridian of *a*, from *a* to *b*; then thro' *b* draw *bc* parallel to *de*, and taking *ac* in your Compasses, apply it to the graduated Equator and it will show the Degrees and Minutes contain'd in the Distance required, which multiplied by 60 will give the Miles of Distance.

The Reason of this is evident from *Art.* 8. of this *Sect.* for 'tis plain *ad* is the inlarg'd difference

of Latitude and *eb* the proper; consequently *ae* the inlarg'd Distance and *ac* the proper.

Prob. 5. To lay down a place upon the *Chart*, it's Latitude and Bearing from some known place upon the *Chart* being known; or (which is the same) having the Course and Difference of Latitude that a Ship has made, to lay down the running of the Ship, and find her place upon the *Chart*.

Example. A Ship from the *Lizard* in the Latitude of 50°, 00′ North, sails S S W till she has differ'd her Latitude 36°, 40′. Requir'd her place upon the *Chart*.

Count from the *Lizard* at L, on the graduated *Meridian* downwards (because the Course is Southerly) 36°, 40′ to *g*; thro' which draw a parallel of Latitude, which will be the parallel the Ship is in; then from L draw a S S W line L *f*, cuting the former parallel in *f*, and this will be the Ship's place upon the *Chart*.

Prob. 6. One Latitude, Course and Distance sail'd, given, to lay down the running of the Ship, and find her place upon the *Chart*.

Example. Suppose a Ship at *a* in the Latitude of 29°, 00′ North, sails North 37°, 20′, East 191 Miles. Required the Ship's place upon the *Chart*.

Having drawn the Meridian and Parallel of the place *a*, set off the Rumb line *a e*, making with *ab* an Angle of 37°, 20′, and upon it set off 191 from *a* to *c*; thro' *c* draw the parallel *cb*, and taking *ab* in your Compasses, apply it to the graduated Equator, and observe the number of Degrees it contains; then count the same number of Degrees on the graduated Meridian from C to *h*, and thro' *h* draw the parallel *he*, which will cut *ac* produc'd in the point *e*, the Ship's place requir'd.

Prob. 7.

Prob. 7. Both Latitudes, and Distance sail'd, given, to find the Ship's place upon the *Chart.*

Example. Suppose a Ship sails from *a*, in the Latitude of 20°, 00′ North, between North and East 191 Miles, and is then in the Latitude of 45°, 00′ North. Requir'd the Ship's place upon the *Chart.*

Draw *de* the parallel of 45°, and set off upon the Meridian of *a* upwards, *ab* equal to the proper difference of Latitude taken from the Equator or graduated Parallel. Thro' *b* draw *bc* parallel to *de*; then with 191 in your Compasses, fixing one foot of them in *a* with the other cross *bc* in *c.* Join *a* and *c* with the right line *ac*, which produc'd will meet *de* in *e* the Ship's place required.

Prob. 8. One Latitude, Course and difference of Longitude, given, to find the Ship's place upon the *Chart.*

Example. Suppose a Ship from the *Lizard* in the Latitude of 50°, 00′ North, sails SW*b*W, till her difference of Longitude is 42°, 36′. Requir'd the Ship's place upon the *Chart.*

Having drawn AE the Meridian of the *Lizard* at L, count from E to F upon the Equator 42°, 36′, and thro' F draw the Meridian FG; then from L draw the SW*b*W line LK and where this meets FG, as at K, will be the Ship's place requir'd.

Prob. 9. One Latitude, Course, and Departure, given, to find the Ship's place upon the *Chart.*

Example. Suppose a Ship at *a* in the Latitude of 20°, 00′ North, sails North 57°, 20′ East, till she has made of Departure 116 Miles. Requir'd the Ship's place upon the *Chart.*

Having drawn the Meridian of *a*, at the Distance of 116, draw parallel to it the Meridian *kl.* Draw the Rumb line *ac*, which will meet *kl* in some point *c*; then thro' *c* draw the parallel *cb*, and

ab

ab will be the proper difference of Latitude, and *bc* the Departure. Take *ab* in your Compasses and apply it to the Equator or graduated Parallel; then observe the number of Degrees it contains, and count so many on the graduated Meridian from C upwards to *b*. Thro' *b* draw the parallel *be*, which will meet *ac* produc'd in some point as *e*, which is the Ship's place upon the *Chart*.

Prob. 10. One Latitude, Distance, and Departure, given, to find the Ship's place upon the *Chart*.

Example. Suppose a Ship at *a*, in the Latitude of 20°, 00′ North, sails 191 Miles between North and East, and then is found to have made of Departure 116 Miles. Requir'd the Ship's place upon the *Chart*.

Having drawn the Meridian and Parallel of the place *a*, set off upon the Parallel *am* equal to 116, and thro' *m* draw the Meridian *kl*. Take the given Distance 191 in your Compasses, setting one foot of them in *a*, with the other cross *kl* in *c*, join *ac*, and thro' *c* draw the Parallel *cb*; so *cb* will be the Departure, and *ab* the proper difference of Latitude; then proceeding with this as in the foregoing *Problem*, you'll find the Ship's place to be *e*.

Prob. 11. The Latitude sail'd from, difference of Latitude and Departure, given, to find the Ship's place upon the *Chart*.

Example. Suppose a Ship from *a* in the Latitude of 20°, 00′ North, sails between North and East, till she be in the Latitude of 45°, 00′ North, and is then found to have made of Departure 116 Miles. Requir'd the Ship's place upon the *Chart*.

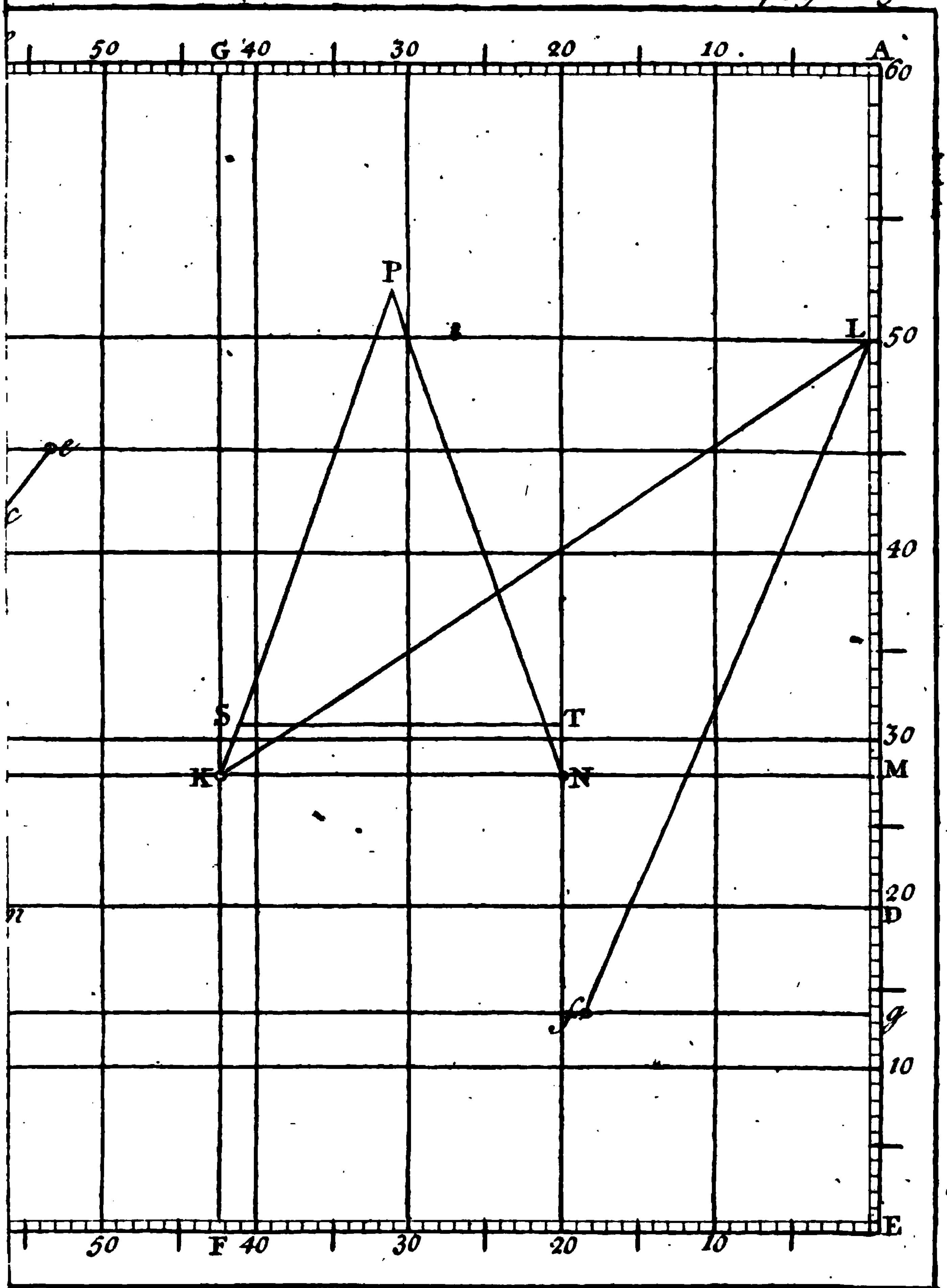
Having drawn the Meridian of *a*, set off upon it from *a* to *b*, 25 Degrees, (taken from the Equator or graduated parallel) the proper difference of Latitude; then thro' *b* draw the Parallel *bc*, and make *be* equal to 116 the Departure, and join *ac*. Count from the Parallel of *a* on the graduated Meridian

Meridian upwards to *b* 25 Degrees, and thro' *b* draw the Parallel *bc*, which will meet *ac* produc'd in some point *c*, and this will be the place of the Ship requir'd.

12. In *Sect.* 7. 'tis plain that the terms *Meridional Distance*, *Departure*, and *difference of Longitude* were synonymous, constantly signifing the same Thing; which evidently follow'd from the supposition of the earth's Surface being projected on a Plain, in which the Meridians were made parallel and the Degrees of Latitude equal to one another and to those of the Equator. But since it has been demonstrated (in this *Section*) that, if in the projection of the earth's Surface upon a Plain, the *Meridians* be made parallel, the Degrees of Latitude must be unequal, still increasing the nearer they come to the *Pole*. It follows that these Terms must denote lines really different from one another. *Difference of Longitude* is defin'd at *Art.* 14. *Sect.* 3. *Meridional Distance* at *Art.* 3. *Sect.* 7. and *Departure* at *Art.* 8. of this *Section*.

A TABLE

page 250.



A

TABLE

OF

Meridional Parts.

L.	0	1	2	3	4	5	6	7	8
M	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.
30	30.0	90.0	150.1	210.1	270.3	330.5	390.8	451.3	511.9
31	31.0	91.0	151.1	211.1	271.3	331.5	391.9	452.3	512.9
32	32.0	92.0	152.1	212.1	272.3	332.5	392.9	453.3	513.9
33	33.0	93.0	153.1	213.1	273.3	333.5	393.9	454.3	514.9
34	34.0	94.0	154.1	214.1	274.3	334.5	394.9	455.3	515.9
35	35.0	95.0	155.1	215.1	275.3	335.5	395.9	456.3	516.9
36	36.0	96.0	156.1	216.1	276.3	336.5	396.9	457.3	518.0
37	37.0	97.0	157.1	217.1	277.3	337.5	397.9	458.4	519.0
38	38.0	98.0	158.1	218.2	278.3	338.6	398.9	459.4	520.0
39	39.0	99.0	159.1	219.2	279.3	339.6	399.9	460.4	521.0
40	40.0	100.0	160.1	220.2	280.3	340.6	400.9	461.4	522.0
41	41.0	101.0	161.1	221.2	281.3	341.6	401.9	462.4	523.0
42	42.0	102.0	162.1	222.2	282.3	342.6	402.9	463.4	524.0
43	43.0	103.0	163.1	223.2	283.3	343.6	403.9	464.4	525.0
44	44.0	104.0	164.1	224.2	284.3	344.6	404.9	465.4	526.0
45	45.0	105.0	165.1	225.2	285.3	345.6	405.9	466.4	527.1
46	46.0	106.0	166.1	226.2	286.3	346.6	407.0	467.4	528.1
47	47.0	107.0	167.1	227.2	287.3	347.6	408.0	468.4	529.1
48	48.0	108.0	168.1	228.2	288.3	348.6	409.0	469.5	530.1
49	49.0	109.0	169.1	229.2	289.3	349.6	410.0	470.5	531.1
50	50.0	110.0	170.1	230.2	290.3	350.6	411.0	471.5	532.1
51	51.0	111.0	171.1	231.2	291.4	351.6	412.0	472.5	533.1
52	52.0	112.0	172.1	232.2	292.4	352.6	413.0	473.5	534.1
53	53.0	113.0	173.1	233.2	293.4	353.6	414.0	474.5	535.1
54	54.0	114.0	174.1	234.2	294.4	354.6	415.0	475.5	536.2
55	55.0	115.0	175.1	235.2	295.4	355.6	416.0	476.5	537.2
56	56.0	116.0	176.1	236.2	296.4	356.6	417.0	477.5	538.2
57	57.0	117.0	177.1	237.2	297.4	357.6	418.0	478.5	539.2
58	58.0	118.0	178.1	238.2	298.4	358.7	419.0	479.6	540.2
59	39.0	119.0	179.1	239.2	299.4	359.7	420.0	480.6	541.2
M	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.
L.	0	1	2	3	4	5	6	7	8

L.	17	18	19	20	21	22	23
M	Min.	Min.	Min.	Min.	Min.	Min.	Min.
0	1035.3	1098.2	1161.5	1225.1	1289.2	1353.7	1418.7
1	1036.3	1099.3	1162.5	1226.2	1290.2	1354.8	1419.7
2	1037.4	1100.3	1163.6	1227.3	1291.3	1355.8	1420.8
3	1038.4	1101.4	1164.7	1228.3	1292.4	1356.9	1421.9
4	1039.5	1102.4	1165.7	1229.4	1293.5	1358.0	1423.0
5	1040.5	1103.5	1166.8	1230.4	1294.5	1359.0	1424.1
6	1041.6	1104.5	1167.8	1231.5	1295.6	1360.1	1425.1
7	1042.6	1105.6	1168.9	1232.6	1296.7	1361.2	1426.2
8	1043.7	1106.6	1170.0	1233.6	1297.8	1362.3	1427.3
9	1044.7	1107.7	1171.0	1234.7	1298.8	1363.3	1428.4
10	1045.8	1108.7	1172.1	1235.8	1299.9	1364.4	1429.5
11	1046.8	1109.8	1173.1	1236.8	1301.0	1365.5	1430.6
12	1047.9	1110.8	1174.2	1237.9	1302.0	1366.6	1431.7
13	1048.9	1111.9	1175.2	1239.0	1303.1	1367.6	1432.8
14	1049.9	1112.9	1176.3	1240.0	1304.2	1368.7	1433.9
15	1051.0	1114.0	1177.4	1241.1	1305.3	1369.8	1434.9
16	1052.0	1115.0	1178.4	1242.2	1306.3	1370.9	1436.0
17	1053.1	1116.1	1179.5	1243.2	1307.4	1372.0	1437.1
18	1054.1	1117.1	1180.5	1244.3	1308.5	1373.1	1438.2
19	1055.2	1118.2	1181.6	1245.4	1309.6	1374.2	1439.3
20	1056.2	1119.2	1182.7	1246.4	1310.6	1375.3	1440.4
21	1057.3	1120.3	1183.7	1247.5	1311.7	1376.4	1441.5
22	1058.3	1121.3	1184.8	1248.6	1312.8	1377.4	1442.6
23	1059.3	1122.4	1185.8	1249.6	1313.8	1378.5	1443.7
24	1060.4	1123.4	1186.9	1250.7	1314.9	1379.6	1444.8
25	1061.4	1124.5	1188.0	1251.8	1316.0	1380.7	1445.8
26	1062.5	1125.5	1189.0	1252.8	1317.1	1381.8	1446.9
27	1063.5	1126.6	1190.1	1253.9	1318.1	1382.8	1448.0
28	1064.6	1127.6	1191.1	1255.0	1319.2	1383.9	1449.1
29	1065.6	1128.7	1192.2	1256.0	1320.3	1385.0	1450.2
M	Min.	Min.	Min.	Min.	Min.	Min.	Min.
L.	17	18	19	20	21	22	23

L.	17	18	19	20	21	22	23
M	Min.	Min.	Min.	Min.	Min.	Min.	Min.
30	1066.7	1129.7	1193.2	1257.1	1321.4	1386.1	1451.3
31	1067.7	1130.8	1194.3	1258.2	1322.4	1387.2	1452.4
32	1068.8	1131.8	1195.4	1259.2	1323.5	1388.3	1453.5
33	1069.8	1132.9	1196.4	1260.3	1324.6	1389.4	1454.6
34	1070.9	1134.0	1197.5	1261.4	1325.7	1390.4	1455.7
35	1072.0	1135.1	1198.5	1262.4	1326.7	1391.5	1456.8
36	1073.0	1136.1	1199.6	1263.5	1327.8	1392.6	1457.9
37	1074.1	1137.2	1200.7	1264.6	1328.9	1393.7	1458.9
38	1075.1	1138.2	1201.7	1265.6	1330.0	1394.8	1460.0
39	1076.2	1139.3	1202.8	1266.7	1331.0	1395.8	1461.1
40	1077.2	1140.3	1203.9	1267.8	1332.1	1396.9	1462.2
41	1078.3	1141.4	1204.9	1268.8	1333.2	1398.0	1463.3
42	1079.3	1142.4	1206.0	1269.9	1334.2	1399.1	1464.4
43	1080.4	1143.5	1207.1	1271.0	1335.2	1400.2	1465.5
44	1081.4	1144.6	1208.1	1272.1	1336.4	1401.3	1466.6
45	1082.5	1145.6	1209.2	1273.1	1337.5	1402.4	1467.7
46	1083.5	1146.7	1210.2	1274.2	1338.6	1403.4	1468.8
47	1084.6	1147.7	1211.3	1275.3	1339.7	1404.5	1469.8
48	1085.6	1148.8	1212.4	1276.3	1340.7	1405.6	1470.9
49	1086.7	1149.8	1213.4	1277.4	1341.8	1406.7	1472.0
50	1087.7	1150.9	1214.5	1278.5	1342.9	1407.8	1473.1
51	1088.8	1152.0	1215.5	1279.5	1344.0	1408.8	1474.2
52	1089.8	1153.0	1216.6	1280.6	1345.0	1409.9	1475.3
53	1090.9	1154.1	1217.7	1281.7	1346.1	1411.0	1476.4
54	1091.9	1155.1	1218.7	1282.7	1347.2	1412.1	1477.5
55	1093.0	1156.2	1219.8	1283.8	1348.3	1413.2	1478.6
56	1094.0	1157.2	1220.9	1284.9	1349.4	1414.3	1479.7
57	1095.1	1158.3	1221.9	1286.0	1350.4	1415.4	1480.8
58	1096.1	1159.4	1223.0	1287.0	1351.5	1416.5	1481.9
59	1097.2	1160.4	1224.1	1288.1	1352.6	1417.6	1483.0
M	Min.	Min.	Min.	Min.	Min.	Min.	Min.
L.	17	18	19	20	21	22	23

L.	24	25	26	27	28	29	30
M	Min.	Min.	Min.	Min.	Min.	Min.	Min.
30	1517.0	1583.2	1649.9	1717.3	1785.2	1853.8	1923.1
31	1518.1	1584.3	1651.0	1718.4	1786.4	1855.0	1924.3
32	1519.2	1585.4	1652.2	1719.5	1787.5	1856.1	1925.4
33	1520.3	1586.5	1653.3	1720.7	1788.6	1857.2	1926.6
34	1521.4	1587.6	1654.4	1721.8	1789.8	1858.4	1927.8
35	1522.5	1588.7	1655.5	1722.9	1790.9	1859.6	1928.9
36	1523.5	1589.8	1656.6	1724.0	1792.1	1860.7	1930.1
37	1524.7	1590.9	1657.8	1725.2	1793.2	1861.9	1931.3
38	1525.8	1592.0	1658.9	1726.3	1794.3	1863.0	1932.4
39	1526.9	1593.2	1660.0	1727.4	1795.5	1864.2	1933.6
40	1528.0	1594.3	1661.1	1728.6	1796.6	1865.3	1934.7
41	1529.1	1594.4	1662.2	1729.7	1797.8	1866.5	1935.9
42	1530.2	1596.5	1663.4	1730.8	1798.9	1867.6	1937.1
43	1531.3	1597.6	1664.5	1731.9	1800.0	1868.8	1938.2
44	1532.4	1598.7	1665.6	1733.1	1801.2	1869.9	1939.4
45	1533.5	1599.8	1666.7	1734.2	1802.3	1871.1	1940.5
46	1534.6	1600.9	1667.8	1735.3	1803.5	1872.2	1941.7
47	1535.7	1602.0	1669.0	1736.5	1804.6	1873.4	1942.9
48	1536.8	1603.1	1670.1	1737.6	1805.7	1874.5	1944.0
49	1537.9	1604.3	1671.2	1738.7	1806.9	1875.7	1945.2
50	1539.0	1605.4	1672.3	1739.9	1808.0	1876.8	1946.4
51	1540.1	1606.5	1673.4	1741.0	1809.2	1878.0	1947.5
52	1541.2	1607.6	1674.6	1742.1	1810.3	1879.2	1948.7
53	1542.3	1608.7	1675.7	1743.2	1811.4	1880.3	1949.9
54	1543.4	1609.8	1676.9	1744.4	1812.6	1881.5	1951.0
55	1544.5	1610.9	1678.0	1745.5	1813.7	1882.6	1952.2
56	1545.6	1612.0	1679.1	1746.6	1814.9	1883.8	1953.4
57	1546.7	1613.1	1680.2	1747.8	1816.0	1884.9	1954.5
58	1547.8	1614.3	1681.3	1748.9	1817.2	1886.1	1955.7
59	1548.9	1615.4	1682.4	1750.0	1818.3	1887.2	1956.9
M	Min.	Min.	Min.	Min.	Min.	Min.	Min.
L.	24	25	26	27	28	29	30

L.	45	46	47	48	49	50	51
M	Min.	Min.	Min.	Min.	Min.	Min.	Min.
0	3030.0	3115.6	3202.8	3291.6	3382.1	3474.5	3568.8
1	3031.4	3117.0	3204.2	3293.1	3383.6	3476.1	3570.4
2	3032.8	3118.5	3205.7	3294.6	3385.2	3477.6	3572.0
3	3034.2	3119.9	3207.2	3296.1	3386.7	3479.2	3573.6
4	3035.6	3121.4	3208.6	3297.5	3388.2	3480.7	3575.2
5	3037.0	3122.8	3210.1	3299.0	3389.7	3482.3	3576.8
6	3038.4	3124.2	3211.6	3300.5	3391.3	3483.9	3578.4
7	3039.8	3125.7	3213.0	3302.0	3392.8	3485.4	3580.0
8	3041.3	3127.1	3214.5	3303.5	3394.3	3487.0	3581.6
9	3042.7	3128.6	3216.0	3305.0	3395.9	3488.5	3583.2
10	3044.1	3130.0	3217.4	3306.5	3397.4	3490.1	3584.8
11	3045.5	3131.5	3218.9	3308.0	3398.9	3491.7	3586.4
12	3047.0	3132.9	3220.4	3309.5	3400.4	3493.2	3588.0
13	3048.4	3134.3	3221.9	3311.0	3402.0	3494.8	3589.5
14	3049.8	3135.8	3223.3	3312.5	3403.5	3496.3	3591.1
15	3051.2	3137.2	3224.8	3314.0	3405.0	3497.9	3592.7
16	3052.6	3138.7	3226.3	3315.5	3406.6	3499.5	3594.3
17	3054.1	3140.1	3227.7	3317.0	3408.1	3501.0	3595.9
18	3055.5	3141.6	3229.2	3318.0	3409.6	3502.6	3597.5
19	3056.9	3143.0	3230.7	3320.0	3411.2	3504.2	3599.1
20	3058.3	3144.5	3232.2	3321.5	3412.7	3505.7	3600.7
21	3059.7	3145.9	3233.6	3323.1	3414.2	3507.3	3602.3
22	3061.2	3147.4	3235.1	3324.6	3415.8	3508.9	3603.9
23	3062.6	3148.8	3236.6	3326.1	3417.3	3510.5	3605.5
24	3064.0	3150.3	3238.1	3327.6	3418.8	3512.0	3607.1
25	3065.4	3151.7	3239.5	3329.1	3420.4	3513.6	3608.7
26	3066.9	3153.2	3241.0	3330.6	3421.9	3515.1	3610.3
27	3068.3	3154.6	3242.5	3332.1	3423.5	3516.7	3611.9
28	3069.7	3156.1	3244.0	3333.6	3425.0	3518.3	3613.6
29	3071.1	3157.5	3245.5	3335.1	3426.5	3519.8	3615.2
M	Min.	Min.	Min.	Min.	Min.	Min.	Min.
L.	45	46	47	48	49	50	51

L.	52	53	54	55	56	57	58
M	Min.	Min.	Min.	Min.	Min.	Min.	Min.
0	3665.2	3763.8	3864.7	3968.0	4073.9	4182.7	4294.3
1	3666.9	3765.5	3866.4	3969.7	4075.7	4184.5	4296.2
2	3668.5	3767.1	3868.1	3971.5	4077.5	4186.3	4298.1
3	3670.1	3768.8	3869.8	3973.2	4079.3	4188.2	4300.0
4	3671.7	3770.4	3871.5	3975.0	4081.1	4190.0	4301.9
5	3673.4	3772.1	3873.2	3976.7	4082.9	4191.8	4303.8
6	3675.0	3773.8	3874.9	3978.5	4084.7	4193.7	4305.7
7	3676.6	3775.4	3876.6	3980.2	4086.5	4195.5	4307.6
8	3678.2	3777.1	3878.3	3982.0	4088.3	4197.4	4309.5
9	3679.9	3778.8	3880.0	3983.7	4090.1	4199.2	4311.4
10	3681.5	3780.4	3881.7	3985.5	4091.9	4201.1	4313.2
11	3683.1	3782.1	3883.4	3987.2	4093.7	4202.9	4315.1
12	3684.8	3783.8	3885.1	3989.0	4095.5	4204.7	4317.0
13	3686.4	3785.5	3886.8	3990.7	4097.3	4206.6	4318.9
14	3688.0	3787.1	3888.6	3992.5	4099.1	4208.4	4320.8
15	3689.7	3788.8	3890.3	3994.2	4100.9	4210.3	4322.7
16	3691.3	3790.5	3892.0	3996.0	4102.7	4212.1	4324.6
17	3692.9	3792.1	3893.7	3997.7	4104.5	4214.0	4326.5
18	3694.6	3793.8	3895.8	3999.5	4106.3	4215.8	4328.4
19	3696.2	3795.5	3897.1	4901.3	4108.1	4217.7	4330.3
20	3697.8	3797.2	3898.8	4003.0	4109.9	4219.5	4332.2
21	3699.5	3798.8	3900.5	4004.8	4111.7	4221.4	4334.2
22	3701.1	3800.5	3902.3	4006.5	4113.5	4223.2	4336.1
23	3702.7	3802.2	3904.0	4008.3	4115.3	4225.1	4338.0
24	3704.4	3803.9	3905.7	4010.0	4117.1	4227.0	4339.9
25	3706.0	3805.5	3907.4	4011.8	4118.9	4228.8	4341.8
26	3707.7	3807.2	3909.1	4013.6	4120.7	4230.7	4343.7
27	3709.3	3808.9	3910.9	4015.3	4122.5	4232.5	4345.6
28	3710.9	3810.6	3912.6	4017.1	4124.3	4234.4	4347.5
29	3712.6	3812.3	3914.3	4018.9	4126.1	4236.2	4349.4
M	Min.	Min.	Min.	Min.	Min.	Min.	Min.
L.	52	53	54	55	56	57	58

	80	81	82	83	84
	Min.	Min.	Min.	Min.	Min.
	8375.3	8[illegible].1	9145.6	9[illegible]	10137.0
	8381.0	8[illegible].5	9152.7	9[illegible]	1014[illegible].6
	8386.8	8[illegible].9	9159.9	9[illegible]	1015[illegible].2
	8392.6	8[illegible].3	9167.2	9[illegible]5	10165.8
	8398.4	8[illegible].8	9174.4	9[illegible]	10175.4
	8404.1	8[illegible].2	9181.6	9[illegible]	10185.1
	8409.9	8[illegible].7	9188.9	9[illegible]	10194.8
	8415.8	8784.1	9196.2	9[illegible]	10204.6
	8421.6	8790.6	9203.5	9[illegible]	10214.4
	8[illegible].4	8797.1	9210.8	9[illegible]6	10224.2
	8[illegible].3	8803.6	9218.1	9[illegible]	10234.0
	8[illegible].1	8810.1	9225.4	9697.4	10243.8
	8[illegible].0	8816.6	9232.8	9705.8	10253.7
	8[illegible].9	8823.2	9240.2	9714.2	10263.6
	8[illegible].8	8829.7	9247.6	9722.7	10273.5
	8[illegible].6	8836.3	9255.0	9731.2	10283.5
	8[illegible].6	8842.8	9262.4	9739.7	10293.5
	8474.5	8849.4	9269.9	9748.3	10303.5
	8480.4	8856.0	9277.3	9756.8	10313.6
	8486.3	8862.6	9284.8	9765.4	10323.7
	8492.3	8869.3	9292.3	977.40	10333.8
	8498.2	8875.9	9299.8	9782.7	10344.0
	8504.2	8882.6	9307.3	9791.3	10354.1
	8510.2	8889.2	9314.8	9800.0	10364.3
	8516.2	8895.9	9322.4	9808.6	10374.5
	8522.2	8902.6	9330.0	9817.3	10384.8
	8528.2	8[illegible].3	9337.5	98[illegible].1	10395.1
	8534.2	8[illegible].0	9345.2	9834.8	10405.4
	8540.2	8[illegible].7	9352.8	9843.6	10415.8
	8546.2	8[illegible].5	9360.4	9852.4	10426.2
M	Min.	[illegible]	Min.	Min.	Min.
L.	80	81	82	83	84

L.	80	81	82	83	84
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
30	8552.3	8936.2	9368.1	9861.3	10436.6
31	8558.4	8943.0	9375.8	9870.1	10447.1
32	8564.4	8949.8	9383.5	9879.0	10457.5
33	8570.5	8956.6	9391.2	9887.8	10468.0
34	8576.6	8963.4	9398.9	9896.7	10478.5
35	8582.7	8970.2	9406.6	9905.7	10489.1
36	8588.9	8977.1	9414.4	9914.6	10499.7
37	8595.0	8983.9	9422.1	9923.6	10510.4
38	8601.1	8990.8	9429.9	9932.7	10521.1
39	8607.3	8997.7	9437.8	9941.7	10531.8
40	8613.5	9004.6	9445.6	9950.8	10542.6
41	8619.6	9011.5	9453.4	[illegible]	10553.3
42	8625.8	9018.4	9461.3	[illegible]	10564.1
43	8632.0	9025.4	9469.1	[illegible]	10574.9
44	8638.2	9032.3	9477.0	[illegible]	10585.8
45	8644.5	9039.3	9484.9	[illegible]	10596.7
46	8650.7	9046.3	9492.9	10005.5	10607.7
47	8656.9	9053.3	9500.8	10014.8	10618.7
48	8663.2	9060.3	9508.8	10024.0	10629.7
49	8669.5	9067.3	9516.8	10033.3	10640.8
50	8675.7	9074.4	9524.8	10042.6	10651.9
51	8682.0	9081.4	9532.9	10051.9	10663.0
52	8688.3	9088.5	9540.9	10061.3	10674.1
53	8694.6	9095.6	9548.9	10070.6	10685.3
54	8701.0	9102.7	9557.0	10080.0	10696.5
55	8707.3	9109.8	9565.1	10089.4	10707.7
56	8713.6	9116.9	9573.2	10098.9	10719.1
57	8720.0	9124.0	9581.4	10108.4	10739.4
58	8726.4	9131.2	9589.5	10117.9	10741.8
59	8732.7	9138.4	9597.7	10127.4	10753.3
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	80	81	82	84	84

L.	85	86	87	88	89
M	Min.	Min.	Min.	Min.	Min.
0	10764.7	11532.6	12522.3	13916.6	16299.8
1	10776.2	11547.0	12541.4	13945.4	16357.5
2	10787.7	11561.4	12560.7	13974.4	16416.3
3	10799.3	11575.9	12580.0	14003.7	16476.1
4	10810.9	11590.5	12599.5	14033.2	16537.0
5	10822.5	11605.0	12619.1	14063.0	16594.9
6	10834.2	11619.8	12638.9	14093.0	16562.0
7	10845.9	11634.5	12658.6	14123.3	16726.2
8	10857.7	11649.3	12678.6	14153.9	16791.7
9	10869.6	11664.1	12698.6	14184.7	16858.5
10	10881.4	11679.1	12718.8	14215.8	16926.5
11	10893.3	11694.0	12739.1	14247.2	16990.6
12	10905.2	11709.1	12759.5	14278.9	17066.9
13	10917.2	11724.2	12780.0	14310.9	17130.3
14	10929.1	11739.4	12800.7	14343.2	17213.2
15	10941.2	11754.7	12821.5	14375.8	17288.7
16	10953.3	11770.0	12842.5	14408.7	17366.0
17	10965.5	11785.4	12863.5	14441.9	17445.0
18	10977.7	11800.9	12884.7	14475.4	17525.9
19	10989.9	11816.4	12906.0	14509.3	17608.7
20	11002.2	11832.0	12927.4	[illegible]5	17693.6
21	1[illegible]5	11847.6	12948.9	[illegible]1	17780.7
22	1[illegible]9	11863.4	12970.6	[illegible]0	17869.9
23	1[illegible]3	11879.2	12992.5	[illegible]	17961.6
24	1[illegible]7	11895.1	13014.4	[illegible]9	18055.8
25	1[illegible]2	11911.0	13036.6	14719.9	18152.6
26	1[illegible]8	11927.1	13058.8	14756.3	18252.3
27	1[illegible]3	11943.1	13081.2	14793.0	18354.9
28	11102.0	11959.4	13103.8	14830.2	18460.7
29	11114.6	11975.6	13126.5	14867.8	18569.8
M	Min.	Min.	Min.	Min.	Min.
L.	85	86	87	88	89

L. / M	85 Min.	86 Min.	87 Min.	88 Min.	89 Min.
30	11127.4	11992.0	13149.3	14905.8	18682.5
31	11140.1	12008.4	13172.3	14944.2	18799.1
32	11152.9	12024.9	13195.5	14983.0	18919.7
33	11165.8	12041.5	13218.8	15022.3	19044.7
34	11178.7	12058.2	13242.3	15062.1	19174.4
35	11191.7	12074.9	13265.9	15102.3	19309.0
36	11204.7	12091.7	13289.7	15143.0	19449.5
37	11217.7	12108.6	13313.7	15184.2	19595.8
38	11230.9	12125.6	13337.8	15225.8	19748.6
39	11244.0	12142.7	13362.1	15268.0	19908.5
40	11257.2	12159.9	13386.6	15310.7	20075.2
41	11270.5	12177.1	13411.2	15354.0	20252.5
42	11283.8	12194.4	13436.4	15397.8	20438.3
43	11297.1	12211.8	13461.1	15442.1	20634.8
44	11310.6	12229.3	13486.3	15487.0	20843.1
45	11324.0	12246.9	13511.6	15532.6	20064.9
46	11337.6	12264.6	13537.2	15578.7	21302.0
47	11351.1	12282.4	13563.0	15625.5	21556.6
48	11364.8	12300.2	13588.9	15673.0	21831.7
49	11378.4	12318.2	13615.1	15721.0	22130.6
50	11392.2	12336.3	13641.4	15769.8	22458.0
51	11406.0	12354.4	13668.0	15819.3	22819.9
52	11419.8	12372.7	13694.7	15869.5	23224.3
53	11433.7	12391.0	13721.7	15920.4	23682.9
54	11447.7	12409.5	13748.9	15972.1	24211.8
55	11461.7	12428.0	13776.3	16024.6	24836.9
56	11475.8	12446.7	13803.9	16077.9	25600.8
57	11489.9	12465.3	13831.7	16132.0	26582.9
58	11504.1	12484.2	13859.8	16187.0	27958.0
59	11518.3	12543.1	13888.1	16242.9	30364.3
M / L.	Min. 85	Min. 86	Min. 87	Min. 88	Min. 89

SECT. XI.

Of Oblique Sailing.

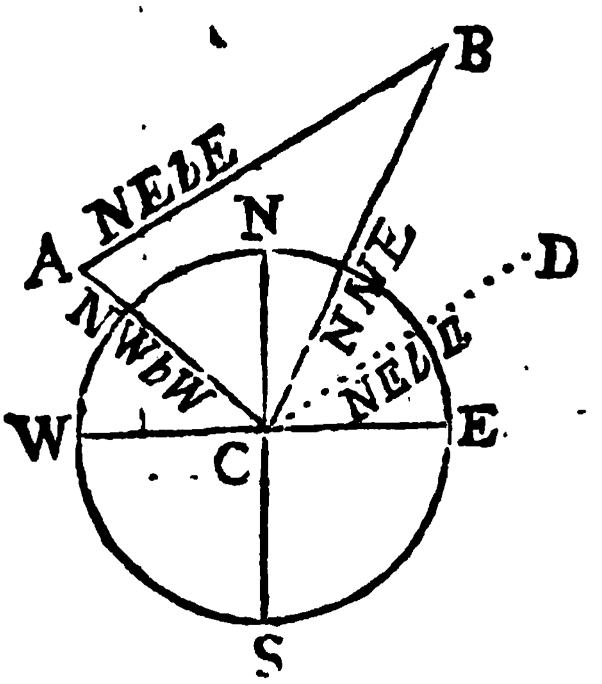
THE Questions that may be propos'd on this Head being innumerable, I shall only give a few of the most useful.

PROB. 1.

Coasting along the Shore I saw a Cape bear from me N N E, then I stood away N W *b* W 20 Miles, and I observ'd the same Cape to bear from me N E *b* E. Required the Distance of the Ship from the Cape at each Station.

Geometrically.

Draw the Circle N W S E to represent the Compass, N S the Meredian and W S the East and West Line, and let C be the place of the Ship in her first Station; then from C set off upon the NW*b*W Line, C A 20 Miles, and A will be the place of the Ship in her second Station.



From C draw the N N E Line C B, and from A draw A B parallel to the N E *b* E Line C D, which will meet C B in B the place of the Cape, and C B will be the Distance of it from the Ship in its first Station, and A B the Distance in the second, to find which

By

By Calculation.

In the Triangle ACB are given AC, equal to 20 Miles, the Angle ACB equal to 78°, 45′, the Distance between the NNE and NW *b* W Lines, also the Angle ABC, equal to BCD (by *Art.* 36. *Sect.* 1.) equal to 33°, 45′, the Distance between the NNE and NE*b*E Lines; and consequently the Angle A equal to 67°, 30′, (by *Cor.* 1. *Art.* 61. *Sect.* 1.)

Hence for CB the Distance of the Cape from the Ship in her first station, it will be (by *Case* 2. of *Oblique Trigonometry.*)

S, ABC : AC :: S, BAC : CB.

i. e. As the sine of the Angle B	33°, 45′	9.74474
is to the Distance run AC	20 - -	1.30103
so is the Sine of BAC	67 ,, 30 -	9.96562
to CB - - - -	33.26 -	1.52191

the Distance of the Cape from the Ship at the first station. Then for AB it will be *by the same Case.*

S, ABC : AC :: S, ACB : AB.

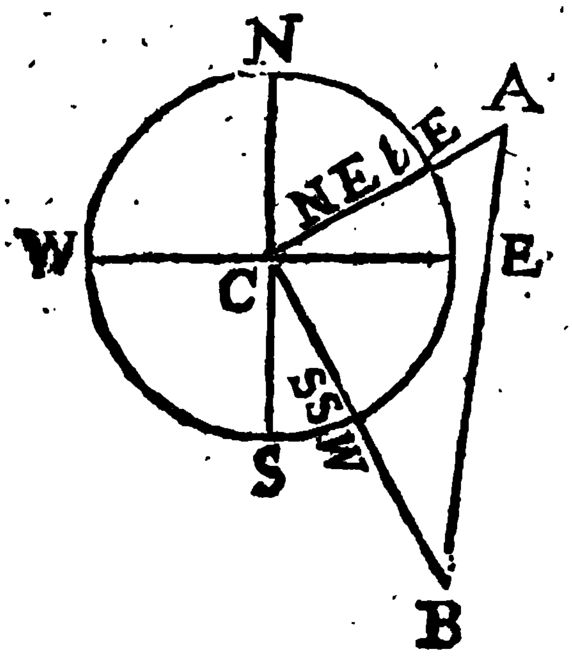
i. e. As the Sine of B - - -	33°, 45′ -	9.74474
is to AC - - -	20 - -	1.30103
so is the Sine of C - -	78 ,, 45 -	9.99157
to AB - - - - -	35.31 - -	1.54786

the Distance of the Ship from the Cape at her second station.

PROB. 2.

Coasting along the Shore I saw two Headlands, the first bore from me NE*b*E 17 Miles, the other SSW 20 Miles. Requir'd the Bearing and Distance of these Headlands from one another.

Geometrically.



Having drawn the Compass NWSE, let C represent the place of the Ship, set off upon the NE *b* E Line CA 17 Miles from C to A, and upon the SSW Line CB 20 Miles from C to B, and join AB, then A will be the first Head-land, and B the second; also AB will be their Distance and the Angle A will be the Bearing from the NE *b* E Line, to find which

By Calculation.

In the Triangle ACB are given, AC 17, CB 20, and the Angle ACB equal to 101°, 15′, the Distance between the NE*b*E and SSW Lines. Hence by *Case* 4. *of Oblique-Angular Trigonometry* it will be

As the Sum of the Sides AC and CB	37	1.56820
is to their Difference - - - - - - -	3	0.47712
so is the Tang. of ½ the Sum of the Angles A and B	39°, 22½′	9.91417
to the Tang. of half their Diff.	3,, 49	8.82309

consequently the Angle A will be 43°, 11′, and the Angle B 35°, 34′; also the Bearing of B from A will be S*b*W 1°, 49′, Westerly, and the Bearing of A from B will NbE 1°, 49′, Easterly.

Then for the Distance AB it will be, (by *Case* 2. of *Oblique Angular Trigonometry*.)

S, A:

S, A : CB :: S, C : AB.

i. e. As the Sine of A -	43°, 11′ -	9.83527
is to CB - - - - - - - -	20 - - -	1.30103
so is the Sine of C - -	101,, 15 -	9.99157
to AB - - - - -	28.67 -	1.45733

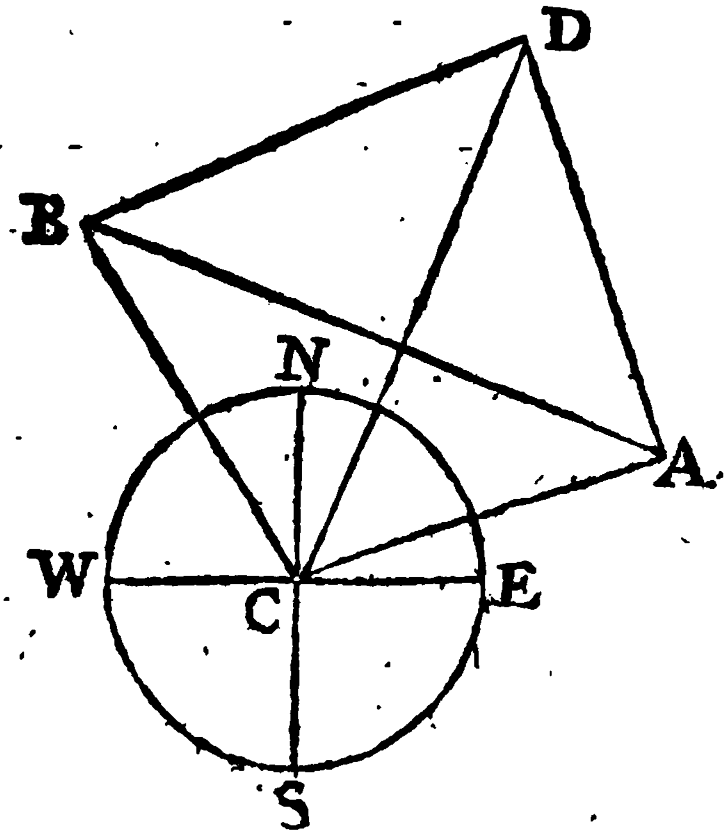
the Distance between the two Headlands.

PROB. 3.

Coasting along the Shore I saw two Headlands, the first bore from me N W *b* N, and the second N N E; then standing away E *b* N ¼ Northerly 20 Miles, I found the first bore from me W N W ½ Westerly and the second N *b* W ½ Westerly. Requir'd the Bearing and Distance of these two Headlands.

Geometrically.

Having drawn the Compass N W S E, let C represent the first place of the Ship, from which



draw the N W *b* N Line CB, and the N N E Line CD, also the E *b* N ¼ N Line CA, which make

 equal

equal to 20. From A draw AB parallel to the WNW ½ W Line, and AD parallel to the N *b* W ½ W meeting the two first Lines in the points B and D; then B will be the first and D the second Headlands. Join the points B and D, and BD will be the distance between them, and the Angle CDB the Bearing from the NNE Line, to find which

By Calculation.

1. In the Triangle ABC are given the Angle BCA, equal to 104°, 04′, the distance between the NW *b* N Line, and the ENE ¼ E Line, the Angle BAC equal to 36°, 34′, the distance between the WSW ¼ W Line and the WNW ½ W Line, the Angle ABC equal to 39°, 22′, the distance between the ESE ½ E Line, and the SW *b* S Line, also the side CA equal to 20 Miles, whence for CB it will be, (*by Case* 2. *of Oblique Trigonometry.*)

As the Sine of CBA	- -	39°, 22′	- 9.80228
is to AC	- - - -	20	- - 1.30103
so is the Sine of CAB	- -	36°, 34′	- 9.77507
to CB	- - - -	18.79	- - 1.27382

the distance between the first Headland, and the Ship in her first station.

2. In the Triangle ACD, are given the Angle ACD equal to 47°, 49′, the distance between the ENE ¼ E Line, and the NNE Line, the Angle CAD equal to 92°, 49′, the distance between the WSW ¼ W Line, and the N *b* W ½ W Line, the Angle CDA equal to 39°, 22′, the distance between the SSW Line, and the S *b* E ½ E Line, also the Leg CA equal to 20.

Hence for CD it will be, (by *the* 2. *Case of Oblique Trigonometry.*)

As

As the Sine CDA	39°, 22′	9.80228
is to AC	20	1.30103
ſo is the Sine of CAD	92°, 34′	9.99960
to CD	31.5	1.49835

the diſtance between the ſecond Headland, and the Ship in her firſt ſtation.

3. In the Triangle BCD are given BC 18.79, CD 31.5, and the Angle BCD equal to 56°, 15′, the diſtance between the NW*b*N Line, and the NNE Line.

Hence for the Angle CDB it will be, (by *Caſe* 4. *of Oblique Trigonometry*)

As the Sum of the Sides	50.29	1.70148
is to the Diff. of Sides	12.71	1.10415
ſo is Tang. of ½ Sum of the unknown Angles	61°, 52′	10.27189
to the Tang. of half their diff.	25°, 18	9.67456

conſequently the Angle CBD is 87°, 10′, and the Angle CDB 36°, 35′. Hence the Bearing of the firſt Headland from the ſecond will be S 59°, 08′, W or SW*b*W ½ W nearly, and for the diſtance between them it will be

As the Sine of BDC	36°, 35′	9.77524
is to BC	18.79	1.27382
ſo is the Sine of BCD	56°, 15′	9.91985
to BD	26.21	1.41843

the diſtance between the two Headlands.

This, and the firſt Problem, are of great uſe in drawing the Plot of any Harbour, or laying down any Sea-Coaſt.

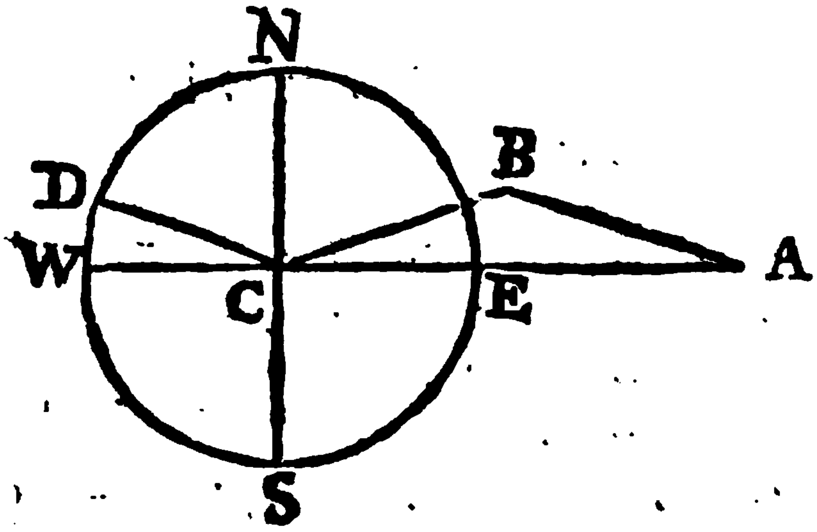
PROB. 4.

Suppoſe a Ship that makes her way good within 6½ points of the Wind, at North, is bound to a Port bearing Eaſt 86 Miles diſtance from her. Requir'd

quir'd the course and distance upon each Tack, to gain the intended Port.

Geometrically.

Having drawn the Compass NESW, let C represent the Ship's place, and set off upon the East line CA 86 Miles, so A will be the intended Port. Draw CD and CB on each side of the North line at 6½ Points distance from it, and thro' A draw AB



parallel to CD meeting CB in B; then the ENE ½ E Line CB will be the Course of the Ship upon the Starboard Tack, and CB its distance on that Tack; also the ESE ½ E Line AB will be the Course on the Larboard Tack, and BA the distance on that Tack, to find which

By Calculation.

In the Triangle ABC are given, the Angle ACB equal to 16°, 53′, the distance between the East and ENE ½ E Line, the Angle CBA equal to 146°, 14′, the distance between the ENE ½ E and the WNW ½ W Lines, the Angle BAC equal to 16°, 53′, the distance between the East, and ESE ½ E Lines, also AC 86 Miles.

Hence since the Angle at A and C are equal, the Legs CB and BA will likewise be equal; to find either of which (suppose CB) it will be, by *Case* 2, *of Oblique-Angled Trigonometry*,

As

As the Sine of B	- -	146°, 14′	- 9.74493
is to AC	- - - - - -	86	- - - 1.93450
ſo is the Sine of A	- -	16,, 53	- - - 9.46303
to CB	- - - - - -	44.94	- - - 1.65260

the diſtance the Ship muſt ſail on each Tack.

There is a great Variety of uſeful Queſtions of this Nature that may be propos'd, but the Nature of them being better underſtood by practice at Sea, we ſhall leave them and go on to *Current Sailing.*

SECT. XII.

Concerning Currents, *and how to make proper Allowances for them.*

1. CURRENTS are certain ſettings of the *Stream*, by which all Bodies (as Ships, &c.) moving therein, are compell'd to alter their Courſe or Velocity, or both; and ſubmit to the Motion impreſſed upon them by the Current.

CASE I.

If the Current ſets juſt with the Courſe of the Ship, (*i. e.*) moves on the ſame Rumb with it; then the Motion of the Ship is increas'd, by as much as is the Drift or Velocity of the Current.

Example.

Suppoſe a Ship ſails S E *b* S at the rate of 6 Miles an Hour, in a Current that ſets S E *b* S 2 Miles an Hour. Requir'd her true Rate of Sailing.

Here it is evident that the Ship's true rate of Sailing, will be 8 Miles an Hour.

CASE

CASE 2.

If the *Current* sets directly against the Ship's Course, then the motion of the Ship is lessen'd by as much as is the Velocity of the *Current.*

Example.

Suppose a Ship sails SSW at the rate of 10 Miles an Hour, in a *Current* that sets NNE 6 Miles an Hour. Requir'd the Ship's true rate of Sailing.

Here it is evident that the Ship's true rate of Sailing will be 4 Miles an Hour. Hence it is plain,

Cor. 1. If the Velocity of the *Current* be less than the Velocity of the Ship, then the Ship will get so much a *Head* as is the difference of these Velocities.

Cor. 2. If the Velocity of the *Current* be greater than that of the Ship, then the Ship will fall so much a *Stern* as is the difference of these Velocities.

Cor. 3. *Lastly*, If the Velocity of the Current be equal to that of the Ship, then the Ship will stand still; the one Velocity destroying the other.

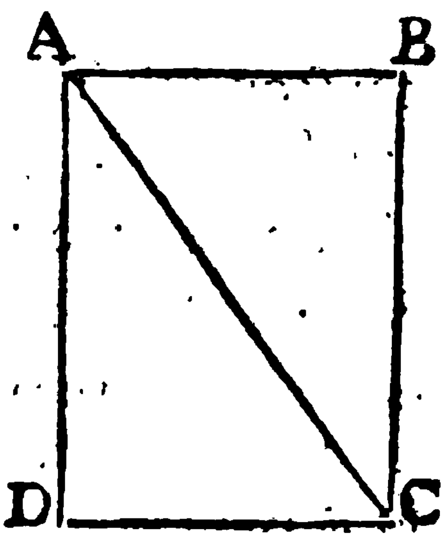
CASE 3.

If the *Current* thwarts the *Course* of the Ship, then it not only lessens or augments her Velocity, but gives her a new direction compounded of the Course she steers, and the setting of the *Current* as is manifest from the following

Lemma.

If a Body at A be impell'd by two Forces at the same time, the one in the direction AB capable

pable to carry that Body from A to B in a certain ſpace of Time, and the other in the Direction A D capable to carry it from A to D in the ſame Time: Compleat the Parallelogram ABCD, and draw the Diagonal A C; then the Body at A agitated by theſe two Forces together will move along the Line A C, and will be in the Point C at the end of the Time in which it would have mov'd along A D or A B with the Forces ſeparately applied.



Hence the Solution of the following Examples will be evident.

Example 1.

Suppoſe a Ship ſails (by the Compaſs) directly South 96 Miles in 24 Hours, in a *Current* that ſets Eaſt 45 Miles in the ſame time. Requir'd the Ship's true Courſe and Diſtance.

Geometrically.

Draw A D (ſee the laſt Scheme) to repreſent the South and North line of the Ship at A, which make equal to 96; from D draw D C perpendicular to A D equal to 45, and join A C. Then C will be the Ship's true place, A C her true diſtance, and the Angle C A D the true Courſe. To find which

By Calculation.

Firſt, For the true Courſe D A C, it will be, by *Caſe* 4. of *Rect-angular Trigonometry*.

As the apparent Diſtance A D	96	-	1.98227
is to the Current's Motion DC	45	-	1.65321

 ſo

so is Radius		10.00000
to the Tangent of the true Course D A C	25°, 07′	9.67094

consequently the Ship's true Course is S 25°, 07′ E or SSE 2°, 37′, Easterly.

Then for the true distance A C, it will be, by *Case* 2. *of Rect-angular Trigonometry*,

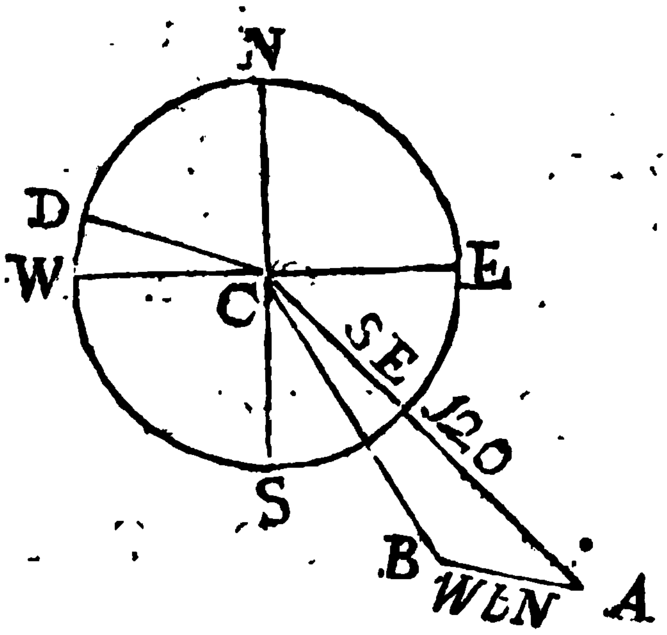
As the Sine of the Course A	25°, 07′	9.62784
is to the Departure D C	45	1.65321
so is Radius		10.00000
to the true Distance A C	106	2.02537

Example 2.

Suppose a Ship sails SE 120 Miles in 20 Hours, in a Current that sets W*b*N at the rate of 2 Miles an Hour. Requir'd the Ship's true Course and Distance sail'd in that time.

Geometrically.

Having drawn the Compass N E S W, let C represent the place the Ship sail'd from; draw the SE



Line C A, which make equal to 120; then will A be the place the Ship caped at.

From

From A draw AB parallel to the W*b*N Line CD, equal to 40, the motion of the Current in 20 Hours, and join CB; then B will be the Ship's true place at the end of 20 Hours, CB her true distance and the Angle SCB her true Course. To find which

By Calculation.

In the Triangle ABC, are given CA 120, AB 40, and the Angle CAB equal to 34°, 45′, the distance between the E*b*S and SE Lines, to find the Angles B and C, and the Side CB.

First, For the Angles C and B it will be, by *Case* 4. *of Oblique Trigonometry*,

As the Sum of the Sides CA and AB	160	2.20412
is to their Difference - - -	80 -	1.90309
so is the Tang. of half the Sum of the Angles B and C	73°, 07′	10.51783
to the Tang. of half their Diff.	59°, 45′	10.21680

consequently the Angle B will be 131°, 52′, and the Angle ACB 14°, 23′. Hence the true Course is S 30°, 37′ E, or SSE 2°, 07′ Easterly.

Then for the true distance CB, it will be, by *Case* 2. *of Oblique Trigonometry*,

As the Sine of B - - -	131°, 52′ -	9.87198
is to AC - - - -	120 - -	2.07918
so is the Sine of A - -	33°, 45′ -	9.74474
to the true Distance CB -	89.53 - -	1.95194

Example 3.

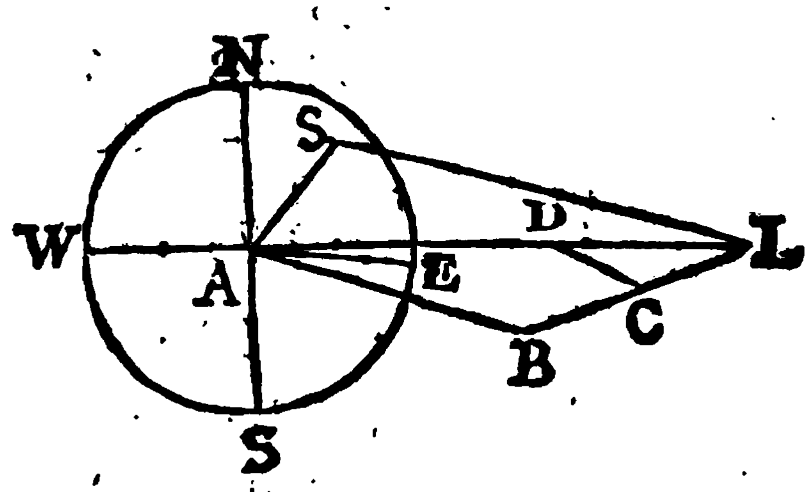
Suppose a Ship coming out from Sea in the Night, has sight of *Scilly* Light, bearing NE*b*N distance 4 Leagues, it being then Flood Tide setting ENE 2 Miles an Hour, and the Ship running after the rate of 5 Miles an Hour. Requir'd upon what

Course and how far she must sail to hit the *Lizard*, which bears from *Scilly* E$\frac{1}{2}$S distance 17 Leagues.

Geometrically.

Having drawn the Compass NESW, let A represent the Ship's place at Sea, and draw the NE *b* N Line AS, which make equal to 12 Miles, so S will represent *Scilly*.

From S draw SL equal to 51 Miles, and parallel to the E$\frac{1}{2}$S Line; then L will represent the *Lizard*.



From L draw LC parallel to the ENE Line, equal to 2 Miles, and from C draw CD equal to 5 Miles meeting AL in D; then from A draw AB parallel to CD meeting LC produc'd in B, and AB will be the requir'd distance, and SAB the true Course. To find which

By Calculation.

In the Triangle ASL are given the side AS equal to 12 Miles, the side SL equal to 51, and the Angle ASL equal to 118°, 07', the distance between the NE *b* N and W$\frac{1}{2}$N Lines, to find the Angles SAL and SLA. Consequently, by *Case* 4. *of Oblique Trigonometry*, it will be

As

As the Sum of the Sides AS and SL	63	1.79934
is to their Difference - - -	39	1.59106
so is the Tang. of half the Sum of the Angles SAL and SLA	30°, 56′	9.77763
to the Tang. of half their Diff.	20°, 21′	9.56935

consequently the Angle SAL, will be 51°, 17′, and so the direct Bearing of the *Lizard* from the Ship, will be N 85°, 02′ E, or E *b* N 6°, 17′ E, and for the distance AL, it will be, by *Case* 2. *of Oblique Trigonometry*,

As the Sine of SAL -	51°, 17′ -	9.89223
is to SL - - - -	51 - -	1.70757
so is the Sine of ASL	118°, 07′ -	9.94546
to AL - - -	57.65 - -	1.76080

the distance between the Ship and the *Lizard*.

Again in the Triangle DLC, are given the Angle L equal to 17°, 32′, the distance between the ENE and N 85°, 02′ E Lines, the side LC equal to 2 Miles, the Current's drift in an Hour, and the Side CD equal to 5 Miles the Ship's Run in the same time. Hence for the Angle D, it will be, by *Case* 1. *of Oblique Trigonometry*,

As the Ship's Run in 1 Hour DC	5 - -	0.69897
is to the Sine of L - -	17°, 32′ -	9.47894
so is the Current's drift LC -	2 - -	0.30103
to the Sine of D - - - -	6°, 55′ -	9.08100

consequently since by Construction the Angle LAB is equal to the Angle LDC, the Course the Ship must steer is S 88°, 03′ E.

Then for the distance AB it will be, by *Case* 2. *of Oblique Trigonometry*,

As the Sine of B - -	155°, 33′ - -	9.61689
is to AL - - - - -	57.65 - - -	1.76080
so is the Sine of L - -	17, 32 - -	9.47894
to AB - - - -	41.96 - - -	1.62285

consequently

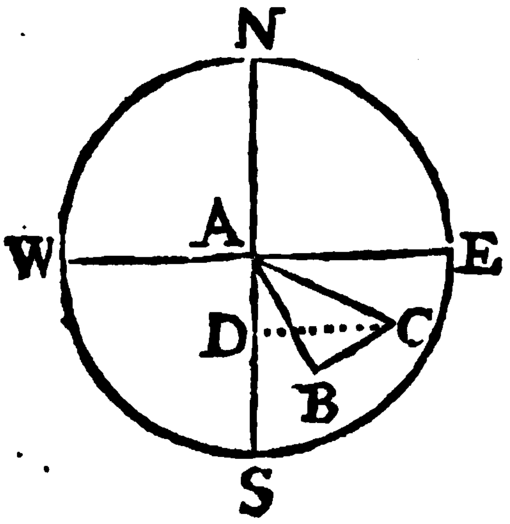
consequently since the Ship is sailing at the rate of 5 Miles an Hour, it follows that in sailing 8^h, 24^m S 88°, 03′ E, she will arrive at the *Lizard.*

Example 4.

A Ship from a certain Headland in the Latitude of 34°, 00′ North, sails SE*b*S 12 Miles in three Hours, in a Current that sets between North and East, and then the same Headland is found to bear WNW, and the Ship to be in the Latitude of 33°, 52′ North. Requir'd the setting and drift of the Current.

Geometrically.

Having drawn the Compass NESW, let A represent the place of the Ship, and draw the SE*b*S line AB equal to 12 Miles, also the ESE line AC.



Set off from A upon the Meridian, AD equal to 8 Miles, the difference of Latitude, and thro' D draw DC parallel to the East and West Line WE, meeting AC in C. Join C and B with the right Line BC; then C will be the Ship's place, the Angle ABC the setting of the Current from the SE*b*S Line, and the Line BC will be the drift of the Current in 3 Hours. To find which

By Calculation.

In the Triangle ABC, right angled at D, are given the difference of Latitude AD equal to 8 Miles, the Angle DAC equal to 67°, 30′. Whence for AC the distance the Ship has sail'd, it will be

As

As Radius - - - - - - - - - -		10.00000
is to the diff. of Latitude A D	8	0.90309
so is the Sec. of the Course D A C	67°, 30′	10.41716
to the distance run A C	20.9	1.32025

Again, in the Triangle A B C, are given A B equal to 12 Miles, A C equal to 20.9 and the Angle B A C equal to 33°, 45′, the distance between the S E *b* S and E S E Lines. Whence for the Angle at B it will be

As the Sum of the Sides AC and AB	32.9	1.51720
is to their Difference - - - -	8.9	0.94939
so is the Tang. of half the Sum of the Angles B and C	73°, 07′	10.51806
to Tang. of ½ their Diff.	41°, 43′½	9.95025

consequently the Angle B is 114°, 51′, and so the setting of the Current will be N 81°, 06′ E or E *b* N 2°, 21′ E. Then for B C the Current's drift in 3 Hours it will be

As the Sine of B - -	114°, 51′	9.92700
is to the Distance run AC	20.9	1.32025
so is the Sine of A - -	33°, 45′	9.74474
to B C - - - - - - - -	12.8	1.10719

the Current's drift in 3 Hours, and consequently the Current sets E *b* N 2°, 21′ E 4.266 Miles an Hour.

SECT.

SECT. XIII.

Concerning the Variation *of the Compass, and how to find it from the true and observ'd* Amplitudes *or* Azimuths *of the Sun.*

1. THE *Variation* of the Compass is how far the North or South point of the *Needle* stands from the true South or North point of the Horizon towards the East or West; or 'tis an Arch of the Horizon intercepted between the Meridian of the place of Observation and the Magnetick Meridian.

2. It is absolutely necessary to know the *Variation* of the Compass at Sea, in order to correct the Ship's Course; for since the Ship's Course is directed by the Compass, 'tis evident that if the Compass be wrong the true Course will differ from the observed, and consequently the whole Reckoning differ from the Truth.

3. The Sun's true *Amplitude* is an Arch of the Horizon comprehended between the true East or West point thereof, and the Center of the Sun at Rising or Setting; or it is the Number of Degrees, &c. that the Center of the Sun is distant from the true East or West point of the Horizon, towards the South or North.

4. The Sun's *Magnetic Amplitude* is the Number of Degrees that the Center of the Sun is from the East or West point of the Compass, towards the South or North point of the same at Rising or Setting.

5. Having the Declination of the Sun, together with the Latitude of the place of Observation, we may from thence find the Sun's true Amplitude, by the following Astronomic Proposition, *viz.*

As the Co-sine of the Latitude
is to the Radius

So

so is the Sine of the Sun's Declination
to the Sine of the Sun's true Amplitude

which will be North or South according as the Declination is North or South.

Example.

Requir'd the Sun's true Amplitude in the Latitude of 41°, 50′ North, on the 23 day of *April* 1731.

First, I find from the third Table at the end of this Book, that the Sun's Declination the 23*d* of *April* 1731, is 15°, 54′ North, then for the true Amplitude, it will be, by the former Analogy,

As the Co-sine of the Lat.	41°, 50′	-	9.87221
is to Radius	- - - -	-	10.00000
so is the Sine of the Decl.	15°, 54′	-	9.43769
to the Sine of the Amplit.	21 ,, 35	-	9.56548

which is North, because the Declination is North at that time; and consequently in the Latitude of 41°, 50′ North, the Sun rises on the 23*d* of *April* 1731, 21°, 35′, from the East part of the Horizon towards the North, and sets so much from the West the same way.

6. The Sun's true *Azimuth* is the Arch of the Horizon intercepted between the Meridian and the Vertical Circle passing thro the Center of the Sun at the time of Observation.

7. The Sun's *Magnetic Azimuth* is the Arch of the Horizon intercepted between the Magnetic Meridian and the Vertical, passing thro' the Sun.

8. Having the Latitude of the place of Observation, together with the Sun's Declination and Altitude at the time of Observation, we may find his true Azimuth after the following Method, *viz.*

Make it,

As the Tangent of half the Compliment of the Latitude
is to the Tangent of half the Sum of the Distance of the Sun from the Pole and Compliment of the Altitude
so is the Tangent of half the Difference between the Distance of the Sun from the Pole and Compliment of the Altitude - - - - - - - - -
to the Tangent of a fourth Arch

which fourth Arch added to half the Compliment of the Latitude will give a fifth Arch, and this fifth Arch lessened by the Compliment of the Latitude will give a sixth Arch; then make it

As the Radius - - - - - - - - - -
is to the Tangent of the Altitude
so is the Tangent of the sixth Arch
to the Co-sine of the Sun's Azimuth

which is to be counted from the South or North, to the East or West according as the Sun is situated with respect to the place of Observation.

If the Latitude of the Place and Declination of the Sun be both North or both South, then the Declination taken from 90° will give the Sun's distance from the Pole; but if the Latitude and Declination be on contrary sides of the Equator, then the Declination added to 90° will give the Sun's distance from the nearest Pole to the place of Observation.

Example.

In the Latitude of 51°, 32′ North, the Sun having 19°, 39′ North Declination, his Altitude was found by Observation to be 38°, 18′. Requir'd the Azimuth.

By

By the first of the foregoing Analogys it will be

As the Tangent of ½ the Compliment of the Latitude	19°, 14′	9.54269
is to the Tangent of ½ the Sum of the Distance of the Sun from the Pole and Compliment of the Altitude	61 ,, 01	10.25655
so is the Tangent of half their Difference	9 ,, 19	9.21499
to the Tang. of a *4th* Arch	40 ,, 20	9.92885

which fourth Arch 40°, 20′, added to 19°, 14′, half the Compliment of the Latitude gives a fifth Arch 59°, 34′, and this fifth Arch lessened by 38°, 28′, the Compliment of the Latitude gives the sixth Arch 21°, 06′; then for the Azimuth it will be by the second of the preceeding Analogys,

As Radius - - - - -		10.00000
is to the Tang. of the Altitude	38°, 18′	9.89749
so is the Tang. of the sixth Arch	21 ,, 06	9.58644
to the Co-sine of the Azimuth	72 ,, 15	9.48393

which, because the Latitude is North and the Sun South of the place of Observation, must be counted from the South towards the East or West; and consequently if the Altitude of the Sun was taken in the Morning, the Azimuth will be S 72°, 15′ E, or ESE 4°, 45′ E; but if the Altitude was taken in the Afternoon, the Azimuth will be S 72°, 15′ W, or W S W 4°, 45′ Westerly.

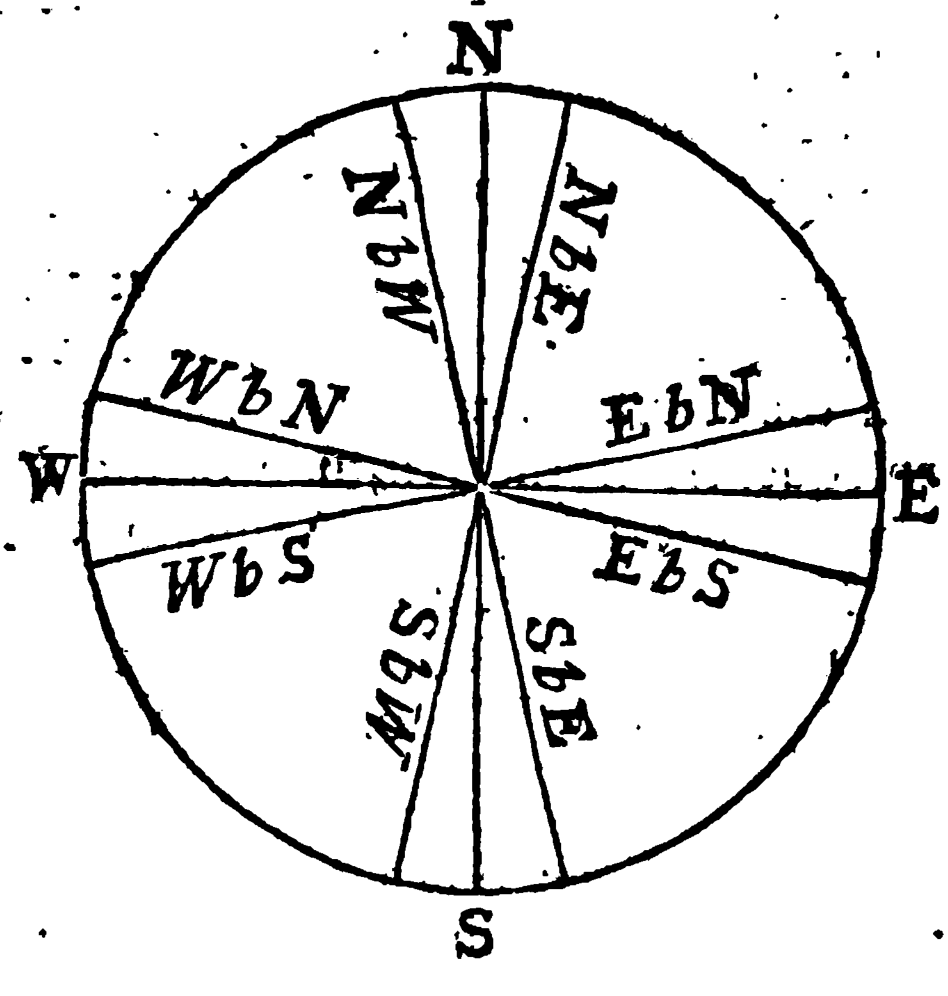
9. Having found the Sun's true Amplitude or Azimuth by the preceeding Analogys, and his Magnetick Amplitude or Azimuth by Observation, 'tis evident if they agree there is no *Variation*; but if they disagree, then if the true and observ'd Amplitudes at the Rising or Setting of the Sun, be both

 of

of the ſame Name, *i. e.* either both North, or both South, their Difference is the *Variation*: But if they be of different Names, *i. e.* one North and the other South, their Sum is the *Variation*. Again, if the true and obſerv'd Azimuths be both of the ſame Name, *i. e.* either both Eaſt or both Weſt, their Difference is the *Variation*; but if they be of different Names their Sum is the *Variation*: And to know whether the *Varation* is *Eaſterly* or *Weſterly*, obſerve this general Rule, *viz.*

Let the Obſerver's Face be turn'd to the Sun, then if the true Amplitude or Azimuth be to the right Hand of the obſerv'd, the *Variation* is Eaſterly; but if to the left, Weſterly.

To explain which, let N E S W repreſent a Compaſs, and ſuppoſe the Sun is really E *b* S at the time of Obſervation, but the Obſerver ſees him off



the Eaſt point of the Compaſs, and ſo the true Amplitude or Azimuth of the Sun, is to the right of the Magnetick, or obſerv'd; here 'tis evident that the

the E*b*S Point of the Compass ought to lie where the East point is, and so the North where the N*b*W is; consequently the North Point of the Compass is a Point too far East, *i. e.* the Varation in this Case is Easterly. The same will hold when the Amplitude or Azimuth is taken on the West side of the Meridian.

Again, let the true Amplitude or Azimuth be to the left Hand of the observ'd; thus suppose the Sun is really E*b*N at the time of Observation, but the Observer sees him off the East Point of the Compass, and so the true Amplitude or Azimuth to the Left of the observ'd: Here it is evident that the E*b*N point of the Compass ought to stand where the East point is, and so the North where the N*b*E point is; consequently the North point of the Compasses lies a point too far Westerly, so in this Case the Variation is West. The same will hold when the Sun is observ'd on the West side of the Meridian.

Example 1.

Suppose the Sun's true Amplitude at Rising is found to be E 14°, 20′ N, but by the Compass it is found to be E 26°, 12′ N. Requir'd the Variation, and which way it is.

Since they are both the same way therefore

From the Magnetick Amplitude -	E 26°, 12′ N.
take the true Amplitude - - -	E 14°, 20′ N.
and there remains the Variation	11 , 52 E.

which is Easterly because in this Case the true Amplitude is to the Right of the observ'd.

Example

Example 2.

Suppose the Sun's true Amplitude at Setting is W 34°, 26′ S, and his Magnetick Amplitude W 23°, 13′ S. Requir'd the Variation and which way it is.

Since they lie both the same way, therefore

From the Sun's true Amplitude	W 34°, 26′ S
take the Magnetick Amplitude	W 23°, 13′ S.
there remains the Variation - -	11 , 13 W.

which is Westerly because the true Amplitude in this Case is to the left Hand of the observ'd.

Example 3.

Suppose the Sun's true Altitude at Rising is found to be E 13°, 24′ N, and his Magnetick E 12°, 32′ S. Requir'd the Variation, and which way it lies.

Since the true and observ'd Amplitudes lie different ways, therefore

To the true Amplitude - -	E 13°, 24′ N.
add the Magnetick Amplitude	E 12 , 32 S.
the Sum is the Variation - -	25 , 56 W.

which is Westerly, because the true Amplitude is, in this Case, to the Left of the observ'd.

Example 4.

Suppose the Sun's true Amplitude at Setting is found to be W 8°, 24′ N, but his Magnetick Amplitude is W 10°, 13′ S. Requir'd the Variation.

To

To the true Amplitude - - -	W 8°, 24′ N.
add the Magnetick - -	W 10°, 13′ S.
the Sum is the Variation - - -	18 , 37 E.

which is Easterly, because the true Amplitude is to the Right of the obſerv'd.

Example 5.

Suppoſe the Sun's true Azimuth at the time of Obſervation, is found to be N 86°, 40′ E, but by the Compaſs it is N 73°, 24′ E. Requir'd the Variation, and which way it lies.

From the Sun's true Azimuth,	N. 86°, 40′ E.
take the Magnetical, - -	N. 73, 24 E.
There remains the Variation, -	13, 16 E.

which is Eaſterly, becauſe the true Azimuth is to the right of the obſerv'd.

Example 6.

Suppoſe the Sun's true Azimuth is S. 3°, 24′ E. and the Magnetical S. 4°, 36′ W. Requir'd the Variation, and which way it lies.

To the true Azimuth. - -	S. 3°, 24′ E.
add the the Magnetical Azimuth.	S. 4, 36 W.
The Sum is the Variation. -	8, 00 W.

which is Weſterly, becauſe the true Azimuth is (in this Caſe) to the Left of the obſerv'd.

10. The Variation of the Compaſs was firſt obſerv'd at *London*, in the Year 1580, to be 11°, 15′ Eaſterly, and in the Year 1622 it was 6°, 0′, E. alſo in the Year 1634, it was 4°, 05′ E. ſtill decreaſing, and the Needle approaching the true Meridian, till it coincided with it, and then there

there was no Variation; after which, the Variation began to be westerly, and in the Year 1672, it was observ'd to be 2°, 30′ W, also in the Year 1683, it was 4°, 30′ W. and since that time the Variation still continues at *London* to encrease westerly; but how far it will go that way, Time and Observations will probably be the only means to discover.

Again, at *Paris*, in the Year 1640 the Variation was 3°, 00′ E. and in the Year 1666, there was no Variation; but in the Year 1681, it was 2°, 30′ W. and still continues to go westerly.

In short, from Observations made in different Parts of the World, it appears, that in different Places the Variation differs both as to its Quantity and Denomination, it being East in one place, and West in another; the true Cause and Theory of which, for want of a sufficient number of Observations, has not as yet been fully explain'd.

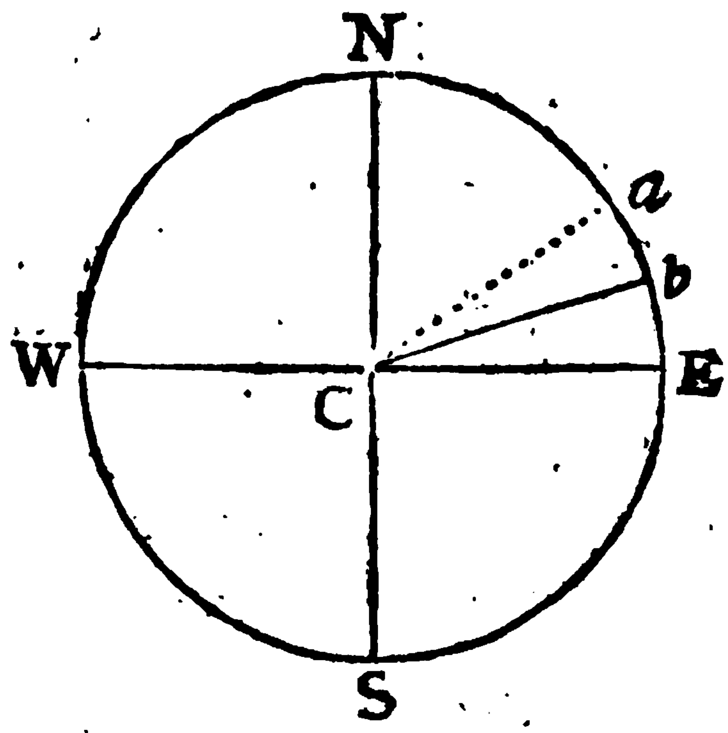
SECT. XIV.

The Method of keeping a Journal at Sea, and how to Correct it, by making proper Allowances for the Lee-way, Variation, *&c.*

1. LEE-WAY is the Angle that the Rumb-Line upon which the Ship endeavours to Sail, makes with the Rumb she really sails upon. This is occasion'd by the force of the Wind, or Surge of the Sea, when she lies to the windward, or is close haul'd, which causes her to fall off and

glide

glide side-ways from the Point of the Compass she capes at. Thus let N E S W represent the Compass and suppose a Ship at C capes at, or endeavours to sail upon the Rumb C*a*; but by the force of the Wind, and Surge of the Sea, she's oblig'd to fall off, and make her way good upon the Rumb C*b*; then the Angle *a* C *b* is the *Lee-way*, and if that Angle be equal to one Point, the Ship is said to make one Point *Lee-way*, and if equal to two Points, the Ship is said to make two Points *Lee-way*, &c.



2. The Quantity of this Angle is very uncertain, because some Ships, with the same quantity of Sail, and with the same Gale, will make more *Lee-way* than others; it depending much upon the Mould and Trim of the Ship, and the quantity of Water that she draws. The common Allowances that are generally made for the *Lee-way*, are as follows:

1. If a Ship be close haul'd, has all her Sails set, the Water smooth, and a moderate Gale of Wind, she is then suppos'd to make little or no *Lee-way*.

2. If it blow so fresh as to cause the small Sails to be handed, 'tis usual to allow one Point.

3. If it blow so hard that the Top-sails must be close reeft, then the common Allowance is two Points for *Lee-way*.

4. If one Top-sail must be handed, then the Ship is suppos'd to make between two and three Points *Lee-way*.

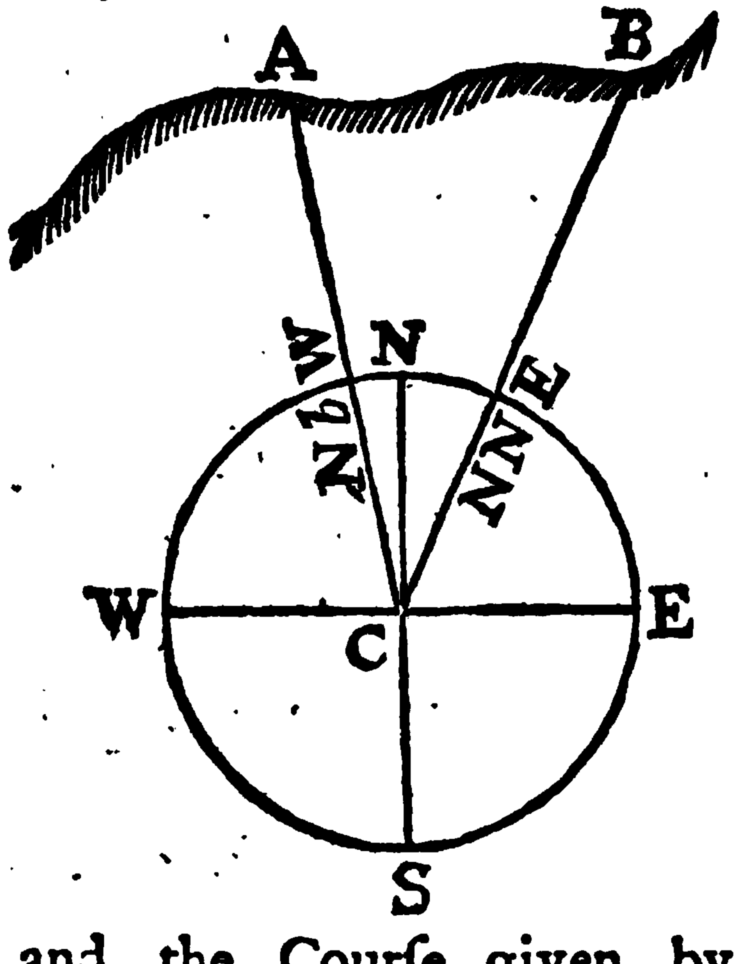
5. When both Top-sails must be handed, then the Allowance is about four Points for *Lee-way*.

6. If it blows so hard, as to occasion the Fore-Course to be handed, the Allowance is between $5\frac{1}{2}$ and 6 Points.

7. When both Main and Fore-Courses must be handed, then 6 or $6\frac{1}{2}$ Points are commonly allow'd for *Lee-way*.

8. When the Mizen is handed, and the Ship is trying a Hull, she is then commonly allow'd about 7 Points for *Lee-way*.

3. Tho' these Rules, are such as are generally made use of, yet since the *Lee-way* depends much upon the Mould and Trim of the Ship, 'tis evident that they can't exactly serve to every Ship; and therefore the best way is to find it by Observation: Thus, let the Ship's *Wake* be set by a *Compass* in the *Poop*, and the opposite *Rumb* is the true *Course* made good by the Ship; then the difference between this and the Course given by the *Compass* in the *Bittacle*, is the *Lee-way* required. If the Ship be within sight of Land; then the *Lee-way* may be exactly found by observing a Point on the Land which continues to bear the same way, and the distance between the Point of the Compass it lies upon, and the Point the Ship capes at, will be the *Lee-way*. Thus, suppose a Ship at C, is lying



ing up N *b* W towards A; but instead of keeping that Course, she is carried on the N N E Line C B, and consequently the Point B continues to bear the same way from the Ship: Here 'tis evident, that the Angle A C B, or the distance between the N *b* W Line that the Ship capes at, and the N N E Line that the Ship really sails upon, will be the *Lee-way*.

4. Having the Course steer'd, and the *Lee-way* given, we may from thence find the true Course by the following Method, *viz.* Let your Face be turn'd directly to the Windward, and if the Ship have her Larboard Tacks on Board, count the *Lee-way* from the Course steer'd toward the Right-hand; but if the Starboard Tacks be on board, then count it from the Course, steer'd towards the Left-hand. Thus suppose the Wind at North, and the Ship lies up within 6 Points of the Wind, with her Larboard Tacks on board, making one Point *Lee-way*; here 'tis plain, that the Course steer'd, is E N E, and the true Course E *b* N; also suppose the Wind is at N N W, and the Ship lyes up within 6½ Points of the Wind with her Starboard Tacks on board, making 1½ Point *Lee-way*; 'tis evident that the true Course, in this Case, is W S W.

5. We have shew'd, in the last Section, how to find the Variation of the Compass; and from what has been said there, we have this general Rule for finding the Ship's true Course, having the Course steer'd and the Variation given, *viz.* Let your Face be turn'd towards the Point of the Compass upon which the Ship is steer'd; and if the Variation be Easterly, count the Quantity of it from the Course steer'd, towards the Right-hand; but if Westerly, towards the Left-hand; and the Course thus found, is the true Course steer'd. Thus, suppose the Course steer'd is N *b* E, and the Varia-

tion one Point Easterly; then the true Course steer'd, will be N N E: Also suppose the Course steer'd is N E *b* E, and the Variation one Point Westerly; then in this Case, the true Course will be N E, and so of others.

Hence, by knowing the *Lee-way Variation*, and *Course* steer'd, we may from thence find the Ship's true Course; but if there a Current under Foot, then that must be try'd and proper Allowances made for it, as has been shown at *Sect.* 12. from thence to find the true Course.

6. After making all the proper Allowances for finding the Ship's true Course, and making as just an Estimate of the distance as we can; yet by reason of the many Accidents that attend a Ship in a Days running, such as different Rates of sailing between the times of heaving the Log, the want of due Care at the Helm, by not keping her steady, but suffering her to yaw and fall off, suddain Storms when no Account can be kept, *&c.* the Latitude, by Account, frequently differs from the Latitude by Observation, and when that happens, 'tis evident there must be some Error in the Reckoning; to discover which and where it lies, and also how to correct the Reckoning, you may observe the following *Rules*.

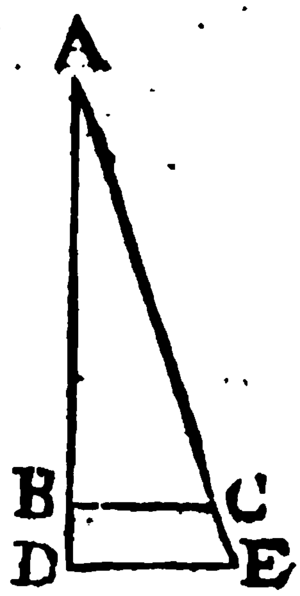
1. If the Ship sail near the Meridian, or within 2 or 2½ Points thereof; then if the Latitude by Account, disagrees with the Latitude by Observation, 'tis most likely that the Error lies in the distance run; for it is plain that in this Case it will require a very sensible Error in the Course to make any considerable Error in the Difference of Latitude, which can't well happen, if due care be taken at the Helm, and proper Allowances be made for the *Lee-way*, *Variation*, and *Currents*. Consequently if the Course be pretty near the Truth, and the Error in the Distance run regu-

larly

larly, thro' the whole, we may from the Latitude, obtain'd by Observation, correct the Distance and Departure by Account, by the following Analogies, *Viz.*

As the Difference of Latitude by Account
is to the true Difference of Latitude,
so is the Departure by Account
to the true departure,
and so is the direct Distance by Account
to the true direct Distance.

The Reason of this is plain, for let A B denote the Meridian of the Ship at A, and suppose the Ship sails upon the Rumb A E near the Meridian, till by Account she is found in C, and consequently her Difference of Latitude by Account is A B; but by Observation she's found in the Parallel E D, and so her true Difference of Latitude is A D, her true Distance A E, and her true Departure D E; then since the Triangles A B C, A D E are similar, it will be A B : A D :: B C : D E and A B : A D :: A C : A E.



Example.

Suppose a Ship from the Latitude of 45°, 20' North, after having sail'd upon several Courses near the Meridian for 24 Hours, her Difference of Latitude is computed to be upon the whole 95 Miles Southerly, and her Departure 34 Miles Easterly; but by Observation she is found to be in Latitude of 43°, 10' North, and consequently her true Difference of Latitude is 130 Miles Southerly; then for the true Departure it will be. As the Difference of Latitude by Account 95, is to the true Difference

Difference of Latitude 130, so is the Departure by Account 34, to the true Departure 46.52, and so is the Distance by Account 100.9, to the true Distance 138.

2. If the Courses are for the most part near the Parallel of East and West, and the direct Course be within $5\frac{1}{2}$ or 6 Points of the Meridian; then if the Latitude by Account differs from the observ'd Latitude, it is most probable that the Error lies in the Course, or Distance, or perhaps both; for in this Case 'tis evident, the Departure by Account will be very nearly true; and thence, by the help of this, and the true Difference of Latitude, may the true Course and direct Distance be readily found *by Case 4th of Plain-Sailing.*

Example.

Suppose a Ship from the Latitude of 43°, 50′ North, after having sail'd upon several Courses near the Parallel of East and West, for the Space of 24 Hours, is found by dead Reckoning to be in the Latitude of 42°, 45′ North, and to have made 160 Miles of Westing; but by a good Observation the Ship is found to be in the Latitude of 42°, 35′ North. Requir'd the true Course, and Direct distance sail'd.

With the true Difference of Latitude 75 Miles, and Departure 160 Miles, we shall find *(by Case 4th of Plain-Sailing)* the true Course to be S 64°, 53′ W, and the direct Distance 176.7 Miles.

3. If the Courses are for the most part near the middle of the Quadrant, and the direct Course within 2 and 6 Points of the Meridian; then the Error may be either in the Course, or in the Distance, or in both, which will cause an Error both in the Difference of Latitude and Depar-

ture,

ture, to correct which, having found the true Difference of Latitude by Observation; with this, and the direct Distance by dead Reckoning, find a new Departure (*by Case 3d of Plain-Sailing*) then half the Sum of this Departure, and that by dead Reckoning, will be nearly equal to the true Departure; and consequently with this, and the true Difference of Latitude, we may (*by Case 4th of Plain-Sailing*) find the true Course and Distance.

Example.

Suppose a Ship from the Latitude of 44°, 38′ North sails between *South* and *East* upon several Courses, near the middle of the Quadrant, for the Space of 24 Hours, and is then found, by dead Reckoning to be in the Latitude of 42°, 15′ North, and to have made of Easting 136 Miles; but by Observation she's found to be in the Latitude of 42°, 04′ North. Requir'd her true Course and Distance.

With the true Difference of Latitude 154 Miles, and the direct Distance by dead Reckoning 197.4 you'll find (*by Case 3d of Plain-Sailing*) the new Departure to be 123.4, and half the Sum of this and the Departure by dead Reckoning will be 124.7 the true Departure; then with this, and the true Difference of Latitude, you'll find (*by Case 4th of Plain-Sailing*) the true Course to be S 39°, 00′ E, and the direct Distance 198.2 Miles.

7. In keeping a Ship's Reckoning at Sea, the common Method is to take from the *Log-board* the several Courses and Distances stemm'd by the Ship last 24 Hours, and to transfer these together with the most remarkable Occurrences into the *Log-Book*, in which also are inserted the Courses corrected,

corrected, and the Difference of Latitude and Difference of Longitude made good upon each; then the whole Day's work being finish'd in the *Log-Book*, if the Latitude by Account agree with the Latitude by Observation, the Ship's place will be truely determin'd; if not, then the Reckoning must be corrected according to the preceeding Rules, and plac'd in the *Journal*.

The Form of the *Log-Book* and *Journal*, together with an Example of 2 Days work, you have here subjoin'd.

Note, To express the Days of the Week, they commonly use the Characters by which the Sun and Planets are express'd, *viz.* ☉ denotes *Sunday*, ☽ *Monday*, ♂ *Tuesday*, ☿ *Wednesday*, ♃ *Thursday*, ♀ *Friday*, and ♄ denotes *Saturday*.

THE

The FORM of the
LOG-BOOK,
With the Manner of working Days Works at *Sea*.

The Log-Book.					
H.	K.	½ K.	Courses.	Winds.	Observations and Accidents. ☽ —— Day of ——
1					Fair Weather, at four this Afternoon I took my Departure from the *Lizard*, in the Latitude of 50°, 00′ North, it bearing N N E, distance five Leagues.
2				North	
3					
4					
5	7		S W *b* S	N *b* E	
6	7				
7	7	1			
8	7	1			
9	6				
10	6				
11	6		S S W	E *b* S	
12	6	1			The Gale increasing and being under all our Sails.
1	6	1			
2	6	1	S W *b* W	N N E	
3	6	1			After three this Morning, frequent Showers with thick Weather till near Noon.
4	7				
5	7	1			
6	8				
7	8				
8	8		S W	E N E	The Variation I reckon to be one Point Westerly.
9	8	1			
10	9				
11	8	1	S W ½ W	N E *b* E	
12	8				

The Log-Book.

Courses Correct.	Dist.	Diff. Lat. N	Diff. Lat. S	Diff. Long. E	Diff. Long. W
S S W	50		46.2		29.4
S *b* W	19		18.6		5.5
S W	49		29.7		45.5
S W *b* S	24.5		20.2		20.0
S W ½ S	25.5		19.5		24.6
			134.2		125.0

Hence the Ship, by Account, has come to the Latitude of 47°, 46′ North, and has differ'd her Longitude 2°, 5′ westerly; so this Day I have made my Way good S 31°, 31′ W, distance 157.4 Miles.

At Noon the *Lizard* bore from me N 31°, 31′ E Distance 157.4 Miles, and having observ'd the Latitude, I found it agreed with the Latitude by Account.

The Log-Book.					
H.	K.	½K.	Courses.	Winds.	Observations and Accidents 1 — Day of —
1	2		SSW	W	This 24 Hours,
2	1	1	Handed the Main		strong Gale of
3	1	1	and Fore Courses		Wind and Vari-
4	1	1	Lee-way 6 Points.		able,
5	1	1			
6	1				
7	1				
8	1	1	The Wind encrea-		
9	1		sing, we try'd a		The Variation I
10	1		Hull, Lee-way 7		judge to be 1
11	1		Points.		Point West.
12	1	1			
1	2		SW*b*W	NW*b*W	
2	1	1	Set Main-sail Lee-		
3	1		way 4½ Points.		
4	1				
5	1				
6	1	1			
7	1				
8	4		S*b*E	SW*b*W	
9	4	1	Set Fore-sail, Lee-		
10	4	1	way 3 Points.		
11	5				Lat. by Observa-
12	4	1			tion, 47°, 06' N.

The

The Log-Book.					
		Diff.	Lat.	Diff.	Long.
Courses Correct.	Dist.	N	S	E	W
S E b E	32.5		17.8	37.7	
E S E	6		2.3	10.6	
S ½ E	9		8.9	1.3	
			29.0	49.6	

Hence the Ship, by Account, has come to the Latitude of 47°, 17′ North, and has differ'd her Longitude 49′ Easterly; consequently she has got 1°, 16′ to the Westward of the *Lizard*, and has made her Way good the last 24 Hours, S 49°, 08′ E, Distance 44.3 Miles.

At Noon the *Lizard* bore from me North 17°, 7′ East, Distance 170.6 Miles.

This Day I had an Observation, and found the Latitude by Account to disagree with the Latitude by Observation by 11 Minutes, I being so much further to the Southward than by dead Reckoning, which by the third of the preceeding Rules I correct as in the *Journal*.

A JOURNAL *from the* Lizard *towards* Jamaica *in the Ship* Neptune, *J. M. Commander.*

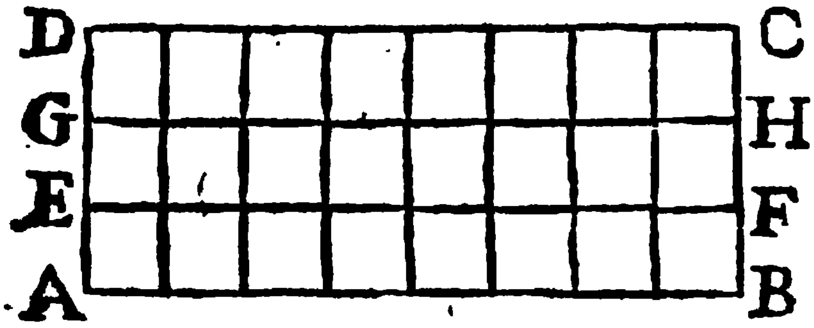
Week Days	Months Years	Month Days	Winds	Direct Course	Dist. Miles	Latitude Correct	Whole Diff Long. made.	Bearing and Dist. from the *Lizard*.	Remarkable Observations and Accidents.
☽	—	—	N *b* E E *b* S N N E E N E N E *b* E	S 31, 31 W	157.4	47°, 46′	2°, 5′ W	At Noon the *Lizard* bore N 31°, 31 E. Dist. 157.4 Miles.	Fair Weather at four *P. M.* I took my Departure from the *Lizard*, it bearing N N E Distance 5 Leagues.
♂		—	West N W *b* W S W *b* W	S 34, 01 E	48.2	47°, 06′	1°, 35′ W	At Noon the *Lziard* bore S 17°, 55 W. Dist. 183 Mi.	Strong Gales of Wind and Variable.

SECT. XV.

Of MENSURATION.

Def. THE *Area* of any plain Surface in Inches, Feet, or any other Meaſure, is the Number of Square Inches, Feet, &c. that the Surface contains.

1. Let A B C D repreſent a Rectangular Parallelogram, and ſuppoſe the Side A B, or D C contains Six equal Parts, and the Side A D or B C three of the ſame Parts; then let the Line A B be



moved along in the Direction of A D till it has come to E F, where A E or F B the diſtance of it from its firſt Situation, may be equal to one of the equal Parts: Here 'tis evident that the generated Parallelogram A B F E will contain as many Squares as the Side A B contains equal Parts (in this Caſe, ſix), each Square having for its Side one of the equal Parts into which A B or A D is divided. Again, let A B move on till it comes to G H, ſo as G E or H F may be equal to A E or B F, then 'tis plain that the Parallelogram A G H B will contain twice as many Squares as the Side A B contains equal Parts, each Square having one of the equal Parts, into which A B or A D is divided, for its Side; and by the ſame way of reaſoning it will appear that the Parallelogram A D C B will contain three times as many Squares as the Side A B contains equal Parts, and in general, that every rectangular Parallelogram contains

contains as many Squares as the Product of the Number of equal Parts in the Base multiply'd into the Number of the same equal Parts in the height contains Units, each Square having for it's Side one of the equal Parts.

Hence arises the Solution of the following Problems.

Problem 1.

To find the Area of a Rectangular Parallelogram.

Rule. Multiply the Base into the perpendicular Height, and the Product is the Area requir'd.

Example.

Suppose the Base A B (see the preceeding Figure) of the Rectangular Parallelogram A B C D, is six Inches in Length; and the perpendicular A D three Inches, requir'd the Area of that Parallelogram in Inches.

6 the Base A B
3 the Perpendicular A D

Product 18 the Area of the Parallelogram A B C D in Inches.

Problem 2.

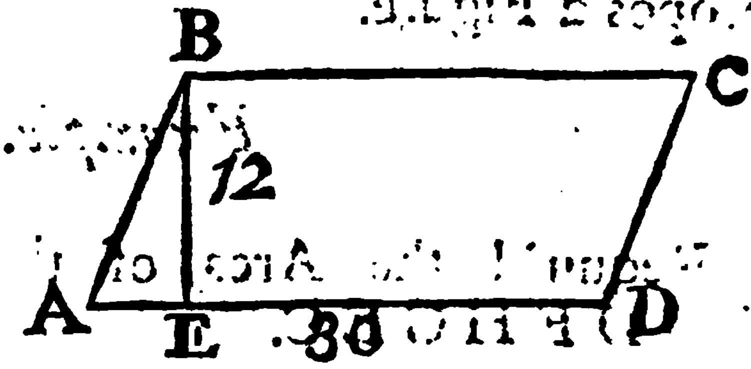
To find the Area of an Oblique-Angular Parallelogram.

Rule. Multiply the Base into the perpendicular Height, and the Product is the Area. The Reason of this Rule is evident from *Art.* 69. *Sect.* 1.

Example

Example.

Suppose the Base A D, of the Oblique-Angular Parallelogram A D C B is 30 Inches, and the perpendicular B E 12 Inches. Requir'd the Area in Inches.



Multiplying 30 the Base into 12 the perpendicular Height, the Product 360, is the Area or Number of square Inches contain'd in the propos'd Figure.

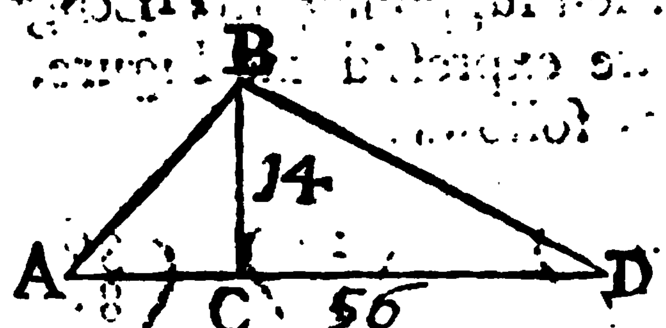
Problem 3.

To find the Area of a Triangle.

Rule. Multiply the Base into half the perpendicular Height, and the Product is the Area requir'd. The reason of this Rule is plain from *Cor.* 3. *Art.* 68. *Sect.* 1.

Example.

In the Triangle A B D, suppose the Base A D is 56 Feet, and the perpendicular B C 14, Requir'd the Area.



The Base 56, multiply'd into 7, half the perpendicular, gives 392 the Area or square Feet contained in the given Triangle.

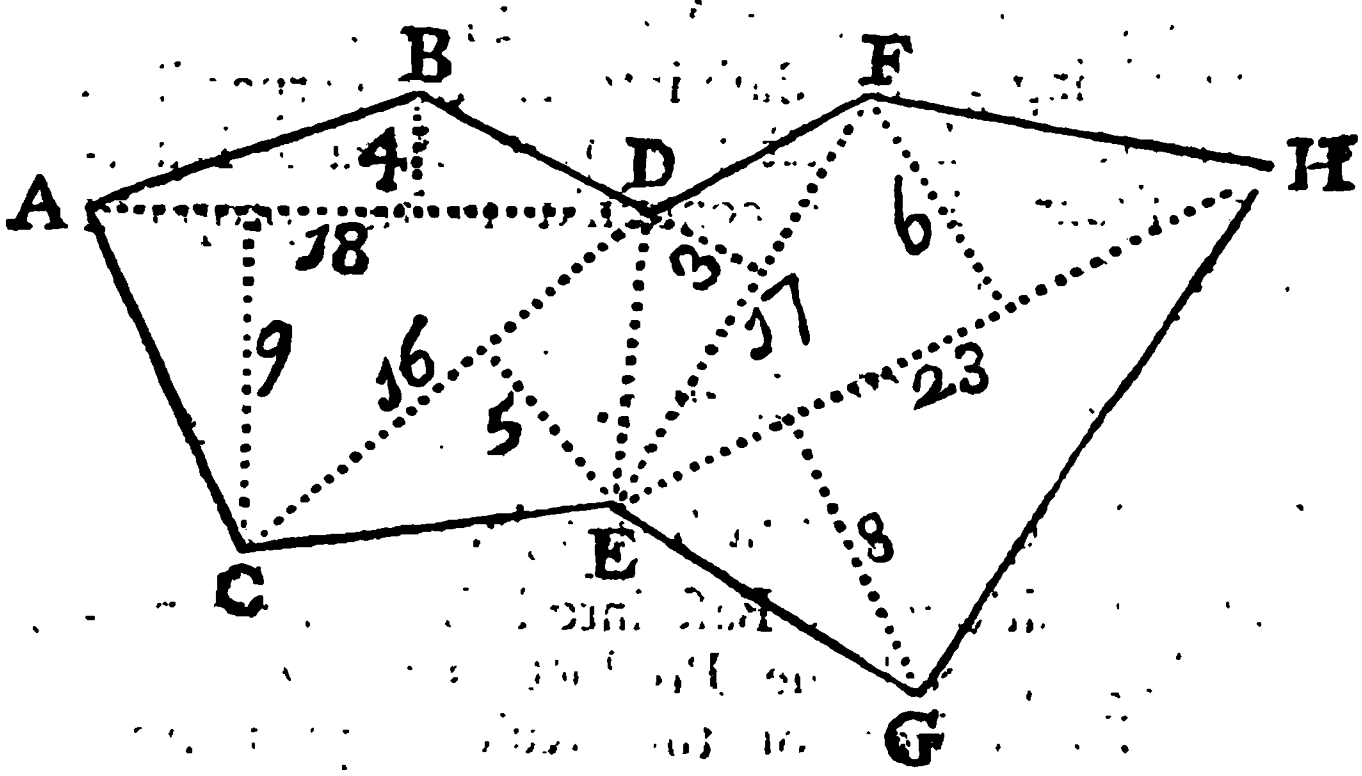
Problem 4.

To find the Area of any irregular Figure.

Rule. Reduce the Figure to Triangles by drawing Diagonals therein; then find the Area of each Triangle and the Sum of these is the Area of the propos'd Figure.

Example.

Requir'd the Area of these irregular Figure A B D F H G E C.



Draw the Diagonals E H, E F, E D, D C and D A, which will divide the Figure into six Triangles, in each of which let fall from any one of it's Angles a Perpendicular to the opposite Side; then supposing the Lengths of these to be as they are express'd the Figure, the Operation will stand as follows:

2	into	18	is	36	The Area of the Triangle	ABD
4.5		18		81		ACD
2.5		16		40		CED
1.5		17		25.5		EDF
3		23		69		EFH
4		23		92		EGH

343.5 the Area of the whole Figure.

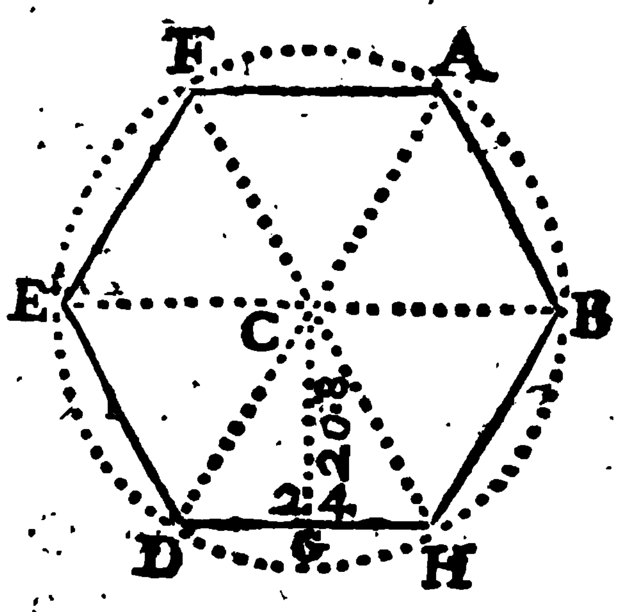
Problem 5.

To find the Area of any regular Polygon.

Rule. Through any three of the Angular Points, draw a Circle (by *Prob.* 8. *Sect.* 1.) which will pass thro' the rest also; then from the Center of this Circle let fall upon any of the Sides a perpendicular, and half this perpendicular multiply'd into the Sum of the Sides will give the Area requir'd.

Example.

Requir'd the Area of the Hexagon A B H D E F, the Center of whose circumscrib'd Circle is C, and the perpendicular C G from the Center upon one of the Sides is 20.8, each Side of the Polygon being 24.



The Sum of the Sides is 144, which multiply'd by 10.4 half the perpendicular, gives 1497.6 the Area of the propos'd Hexagon.

2. It has been found by Calculation that if the Diameter of a Circle be 1, the Circumference of the same will be 3.1416 nearly; and consequently the Diameter of any Circle will be to its Circumference as 1 to 3.1416, & *e contra.*

Cor. 1. Hence, multiplying the Diameter of of any Circle by 3.1416 the Product will be the Circumference. Thus, let the Diameter of a Circle be 36; then 36 multiply'd by 3.1416 will give 113.0976 the Circumference of the propos'd Circle.

Cor. 2. Hence, dividing the Circumference of a Circle by 3.1416, the Quotient will be the Diameter. So if the Circumference of a Circle be 75.3984; then this divided by 3.1416 will give 24 the Diameter of the propos'd Circle.

Now a Circle being a Polygon of an infinite Number of Sides, the Sum of all which is the Circumference, and the perpendicular on any of them, the Radius; therefore

Problem 6.

Given the Diameter of a Circle, to find its Area.

Rule. First find the Circumference (by the first of the preceeding *Corollaries*) then multiply that by half the Radius, and the Product is the Area.

Example.

Requir'd the Area of a Circle whose Diameter is 36.

First, I find the Circumference is 113.0976, which multiply'd by 9 half the Radius, gives 1017.8784 the Area requir'd.

Problem 7.

The Circumference of a Circle given, to find its Area.

Rule. Find the Diameter, by *Cor.* 2; then multiply the Circumference by half the Radius, and the Product is the Area.

Example.

Requir'd the Area of a Circle, whose Circumference is 75.3984.

First,

First, I find the Diameter to be 24; then multiplying the Circumference 75.3984 by half the Radius, *viz.* 6, the Product 452.3904 is the Area requir'd.

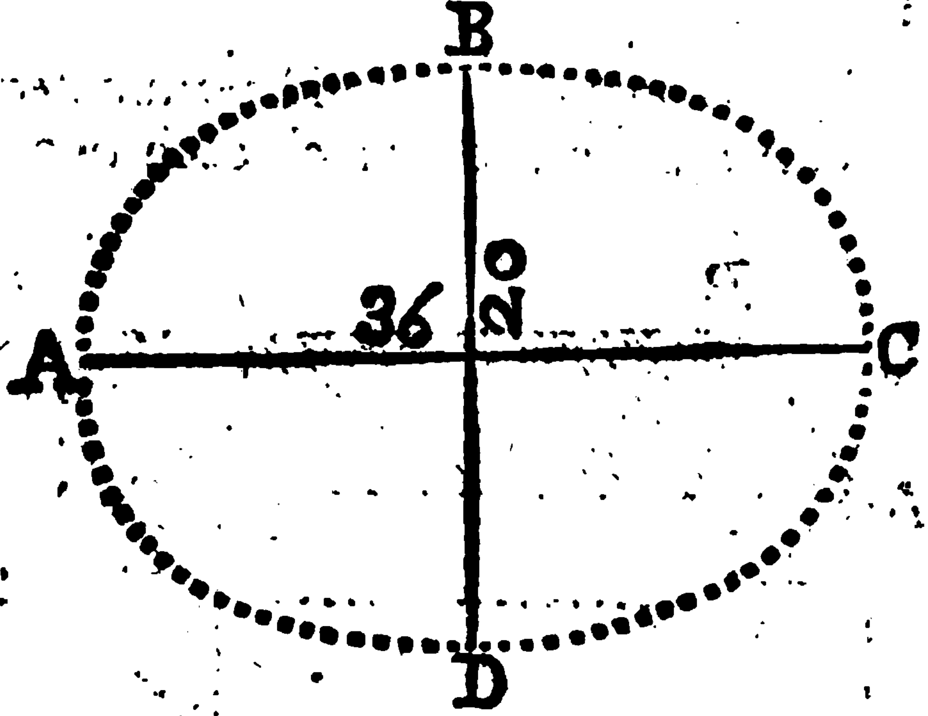
Problem 8.

To find the Area of an Ellipse.

Rule, Multiply the greatest Diameter into the least; and the Product into .7854, and this last Product is the Area.

Example.

Suppose in the Ellipse A B C D the greatest



Diameter A C is 36, and the least Diameter B D 20. Requir'd the Area of that Ellipse.

Multiplying 36 into 20, the Product is 720, which multiply'd into .7854, gives 565.488 the Area of the propos'd Ellipse.

3. A

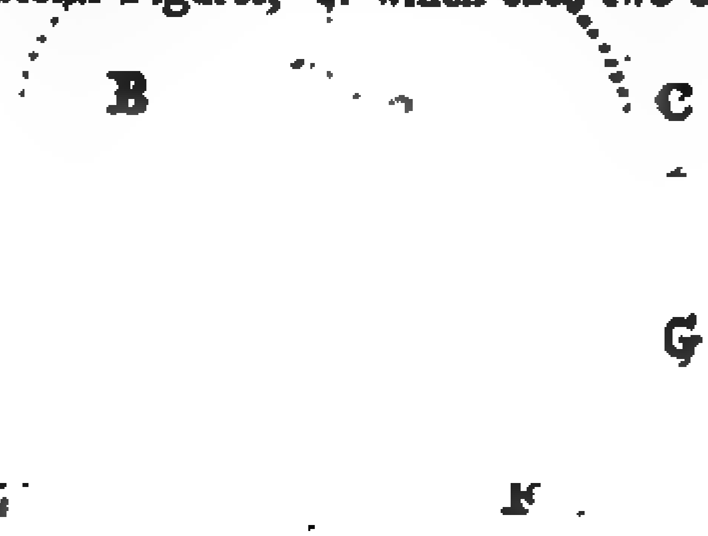
3. A *Solid* is that which has length, breadth and thickness.

4. A *Cube* is a Solid bounded by Six equal Squares. Thus the Solid A B C G F E H D bounded by the six equal Squares A B C D, C D F G, A D F E, A B H E, B C G H and H G F E is a Cube.

If the terminating Squares be square Inches, then the Solid is call'd a Cubic Inch; if square Feet, a Cubic Foot, *&c.*

5. The Solidity of any Body in Inches, Feet, *&c.* is the Number of Cubic Inches, Feet, *&c.* the Body contains.

6. A *Parallelippiped* is a Solid terminated by six Quadrilateral Figures, of which each two opposite



to one another are equal and parallel, as A B C G F D H E.

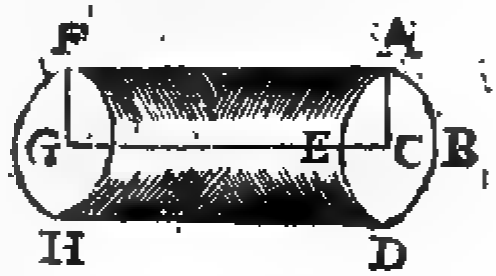
The Solidity of this Body is found by multiplying the Length, Breadth, and Thickness, into one another; and the Product is that requir'd.

Example. Suppose in the *Parallelippiped* A B C D F G H E, the Length E F is 36 Feet, the Breadth D F 16, and the Thickness F G 12; then these

these three multiply'd into one another will give 6912 for the Solidity, or number of Cubic Feet the propos'd Body contains.

The Area of the Surface, or superficial Content of that Body, is found by taking the Sum of the Areas of the Quadrilateral Figures that terminate it.

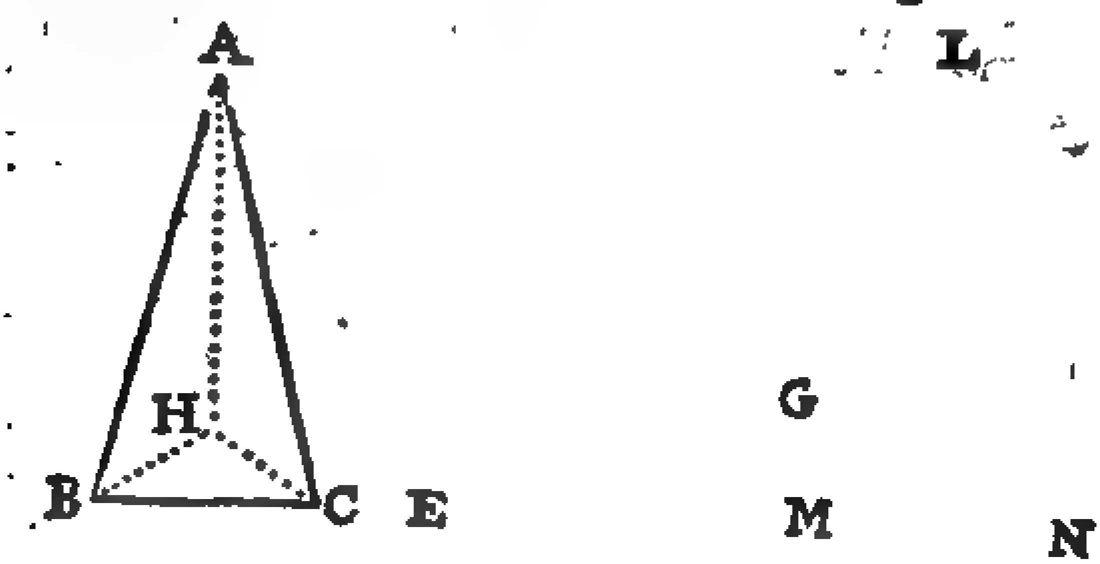
7. If in a rectangular Parallelogram A C G F, one of the Sides G C remain fix'd, and the Paralelogram move quite round to its first Place; then the generated Solid A D H F is call'd a Cylinder.



The Solidity of this Body is found by multiplying the Area of one of its circular Bases into the Length. Thus let the Radius A C of one of the Bases of the *Cylinder* be 6 Inches, and the Length A F 36; then the Area of the Base A B D E will be 113.0976 (by *Problem* 6.) which multiply'd into the Length 36, gives 4071.5136 for the Solidity.

The superficial Content is found by multiplying the Circumference of one of the Bases into the Length, and to the Product adding the Areas of the two Bases.

8. Solids that decrease from the Base gradu-



ally till they come to a Point, are in general call'd

call'd *Pyramids*, and are of different Kinds, according to the Figure of their Bases. Thus a Pyramid, having a Triangular Base, is called a *Triangular Pyramid*, as ABCH, and if the Base be a Parallelogram, it's call'd a *Parallelogramick Pyramid* as DEFGK, and if a Circle, it's call'd a *Circular Pyramid*, or simply a *Cone*, as LMN, *&c.* The Point in which the Pyramid ends, is call'd, the *Vertex*, and a Line drawn from the Vertex perpendicular to the Base, is call'd, the *Height* of the *Pyramid.*

The Solidity of a *Pyramid* is found by multiplying the Area of the Base into $\frac{1}{3}$ the Height. Thus suppose the Diameter of the Base of a *Cone* is 24 Inches, and the Height 51, then the Area of the Base will be 452.3904, which multiply'd by 17, the third Part of the Height, gives 7690.6368. The superficial Content of a Cone is found by multiplying the Circumference of the Base into half the Line joining the Vertex and any Point in that Circumference, and to that Product adding the Area of the Base.

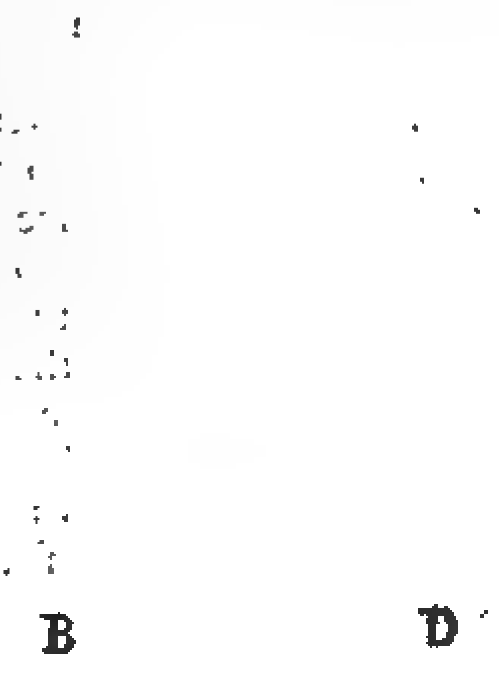
9. If a Semicircle be turn'd quite round upon its Diameter as an Axis, it will generate a Solid call'd a *Globe* or *Sphere*.

The Area of the Surface of a Globe, is found by multiplying the Diameter into the Circumference of a great Circle upon it. Thus suppose the Diameter of a Globe is 16 Inches; then the Circumference of a great Circle upon that Globe will be 50.2656, which multiply'd by 16 the Diameter, gives 804.2496 for the superficial Content in Inches.

The Solidity of a Globe, is found multiplying the superficial Content by $\frac{1}{6}$ the Diameter. Thus suppose the Diameter of a Globe is 18, then the Area of the Surface will be 1017.8784 which multiply'd by 3 gives 3053.6352 for the Solidity.

10. We

10. We have shewn how to find the Solidity of a Cone, having the Diameter of the Base, and the Height given, and thence we have a Method of finding the Solidity of a Frustum of a Cone, having the Diameter of the two Bases and the Height of the Frustum given. Let F B D G denote a Frustum of the Cone A B D, B D the greatest, and F G the least Diameter of the Frustum. Join the Vertex of the Cone A, and the Center of the Base C with the right Line A C which will pass thro' H the Center of the least Base of the Frustum, and thro' G draw G E parallel to A C, which will be equal to H C the Height of the Frustum; then 'tis evident that E D will be the difference between the greatest and least Semidiameters of the Frustum, and since the Triangles A C D and G E D



are similar, therefore (by *Art.* 74. *Sect.* 1.) D E : D C :: E G : C A, *i. e.* as the difference between the greatest and least Semidiameters of the Frustum, is to the greatest Semidiameter, so is the Height of the Frustum, to the Height of the whole Cone. Consequently having the Diameter of the Base, and Height of the whole Cone we can find its Solidity; and from A C, the Height of the whole Cone, taking C H the Height of the Frustum, we have A H the Height of the Cone cut off, with which, and the Base F G, which is given, we may find the Solidity of the Cone cut off, A F G. Consequently from the Solidity of the whole Cone A B D taking the Solidity of the small Cone A F G, there will remain the Solidity of the Frustum F B D G.

Example. Suppose the greatest Diameter of the Frustum of a Cone is 20 and the least 12, and the height 12; then the difference between the two Semidiameters will be 4, and making it as 4 : 10 :: 12 : 30; we have 30 for the Height of the whole Cone, and from 30 taking 12, there remains 18 the Height of the least Cone; so the Solidity of the whole Cone is 3141.6, and the Solidity of the least Cone is 678.5856, the difference of these is 2463.0144, which is the Solidity of the propos'd Frustum.

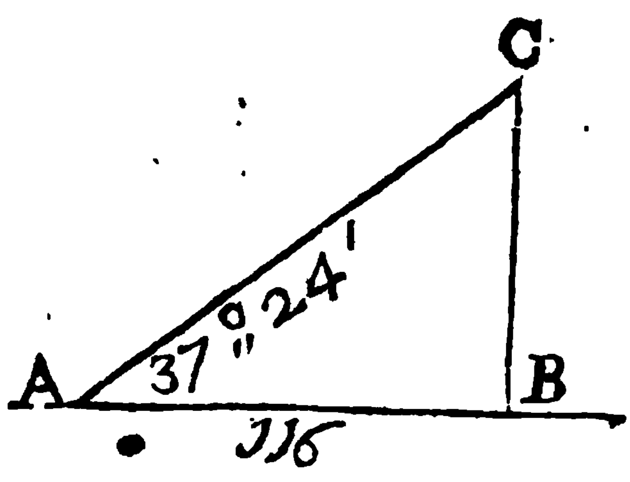
The Superficial Content of a Frustum of a Cone is found by adding to the superficial Content of the whole Cone, twice the Area of the Base of the small Cone, and from that Sum taking the superficial Content of the small Cone.

11. We have in the preceeding part of this Book, shewn the Use of Plain Trigonometry in solving Problems of Navigation; and now we shall apply it in the following Problems, to the Measuring the Heights of accessable and inaccessable Objects.

Problem 1.

To find the Height of any accessable Object.

Let BC be the Object to be observ'd, and from any Point A in the Level upon which the Object stands, let the Angle of Altitude CAB be observed, and measure the distance AB; then in the Right Angled Triangle ABC are given the two oblique Angles A and C, and the Side AB, whence



to find BC it will be, *by Case* 1. *of Rectangular Trigonometry*,

R : T, A :: AB : BC.

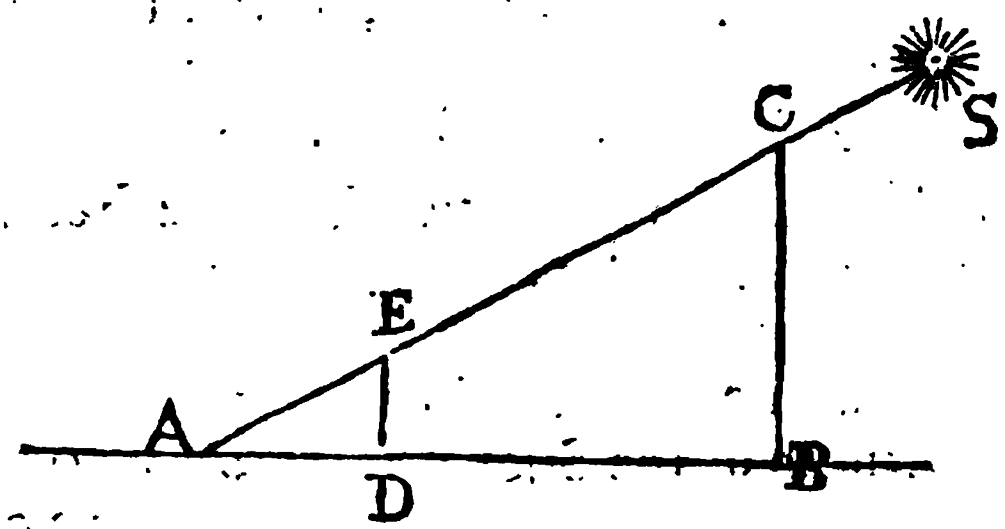
Example.

Example. Suppose the Angle of Altitude C A B is 37°,, 24′ and the Length A B 116 Feet, then for B C it will be

As Radius - - - - - - - - -		10.00000
is to the Tang. of Altitude -	37°,,24′	9.88341
so is A B - - - - - - -	116 -	2.06446
to the Height of the Object B C	88.69 -	1.94787

Note, In taking the Height of any Object, if the Eye be not in the Level upon which the Object stands; then to or from the Height found, you must add or subtract the distance of the Eye from the Level, according as it is placed above or below it, and the Sum, or Difference, is the true Height of the Object.

The Height of an accessable Object may also be found by means of its Shadow. Thus suppose C B is the Object and B A, its Shadow, caus'd

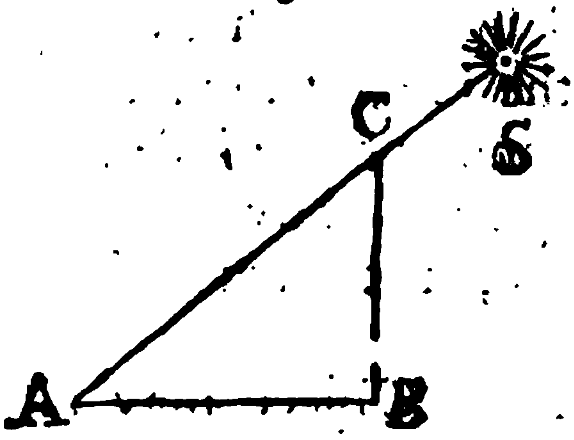


by the Sun at S, and let D E be a Stick of a known length, plac'd perpendicular to the Line of the Shadow, and in some Point of it D, so as the Extremity of the Shadows of the Object and Stick may coincide at A. Measure A D and A B the Lengths of the Shadows, and then since E D and C B are both perpendicular to A B, it will be; as A D the Stick's Shadow, is to D E the Length of the Stick, so is A B the Object's Shadow, to C B the Height of the Object.

Problem 2.

To find the Altitude of the Sun by the Length of the Shadow of an accessable Object, whose measure is also known.

Let C B represent a Stick, or any other accessable Object of a known Length, standing perpendicular to the Horizontal Plain A B, and let A B be its Shadow made by the Sun at S. Measure the length of the Shadow A B, and then in the Right Angled Triangle A B C are given the two Sides A B and B C, whence to find the Angle C A B, or the Altitude of the Sun at the time of Observation, it will be, *by Case 4th of Rectangular Trigonometry*,



A B : B C :: R : T, A.

Example. Suppose the Stick B C is 4 Feet, and the Shadow of it A B 5, then for the Sun's Altitude it will be

As the Length of the Shadow	5 -	0.69897
is to the Length of the Stick - -	4 -	0.60206
so is Radius - - - - - - - - -	-	10.00000
to the Tang. of the Sun's Alt.	38°, 39'	9.90309

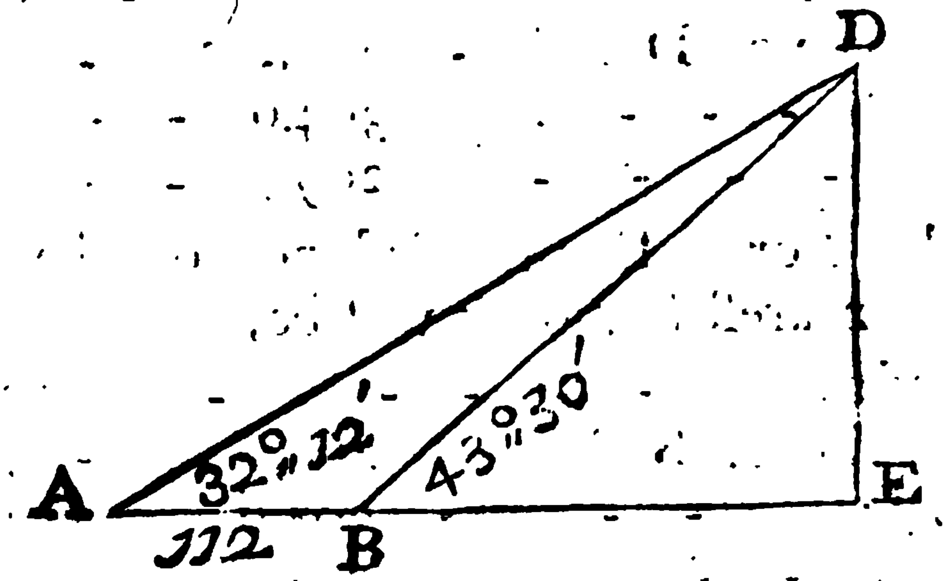
Problem 4.

To find the Height and Distance of an inaccessable Object.

Let D E represent an inaccessable Object, and B a Point in the Horizontal Plane on which it stands, and from whence we can observe the Angle of Altitude D B E. At any other Point in the same Plain as A, observe the Angle of Altitude D A E,

and

and meaſure the Length of A B the Diſtance between the two Stations A and B; then in the Tri-



angle A B D having the external Angle D B E together with the internal oppoſite one A, we have the Angle A D B (*by Art.* 60. *Sect.* 1.) and alſo the Side A B; whence for B D the Hypothenuſe of the right angled Triangle D B E, it will be, *by Caſe* 2. *of Oblique Angled Trigonometry*,

S, A D B : A B :: S, A : B D.

Then in the Right Angled Triangle B D E are given the Hypothenuſe B D and the Oblique Angles; whence for D E the Height of the Object, it will be, *by Caſe* 3*d of Rectangular Trigonemetry*,

R : S, D B E :: B D : D E.

And for B E the Diſtance of the Object from the neareſt Station, it will be, by the ſame,

R : S, B D E :: B D : B E.

Example. Suppoſe the Angle of Altitude at B is 43°,, 30′ and at A 32°,, 12′ and the Diſtance A B between the two Stations is 112 Feet; then the Angle A D B will be 11°,, 18′ and the Angle B D E will be 46°,, 30′. Hence for B D it will be

As the Sine of A D B -	11°,, 18′ -	9.29214
is to A B - - - - - -	112 - -	2.04922
ſo is the Sine of A - - -	32°,, 12′ -	9.72663
to B D - - - - - -	304.6 - -	2.48371

Then

Then for D E the Height of the Object it will be.

As Radius	- - - - - - - - - -		10.00000
is to the Sine of D B E	-	43°,, 30′ -	9.83781
so is B D	- - - - - - -	304.6 - -	2.48371
to D E	- - - - - - -	209.7 - -	2.32152

Lastly, For B E the Distance of the Object from the nearest Station it will be,

As Radius	- - - - - - - - - -		10.00000
is to the Sine of B D E	-	46°,, 30′ -	9.86056
so is B D	- - - - - - -	304.6 - -	2.48371
to B E	- - - - - - - -	221 - - -	2.34427

If the Object stands upon a Rising Ground, then find the Height of the Object above the Plain on which you stand (*by the last Problem*) as also the Height of some Point on the Rising Ground near the Foot of the Object, and this last Height taken from the former will give the true Height of the Object.

SECT. XVI.

Of SURVEYING.

1. THE Instruments chiefly in Use for taking Angles in the Field are, the *Plain-Table*, *Theodolite*, *Compass*, *Semicircle*, &c. The Nature and Use of which is much easier obtain'd by viewing the Instruments themselves, than by a Description of them, from their Draughts upon Paper.

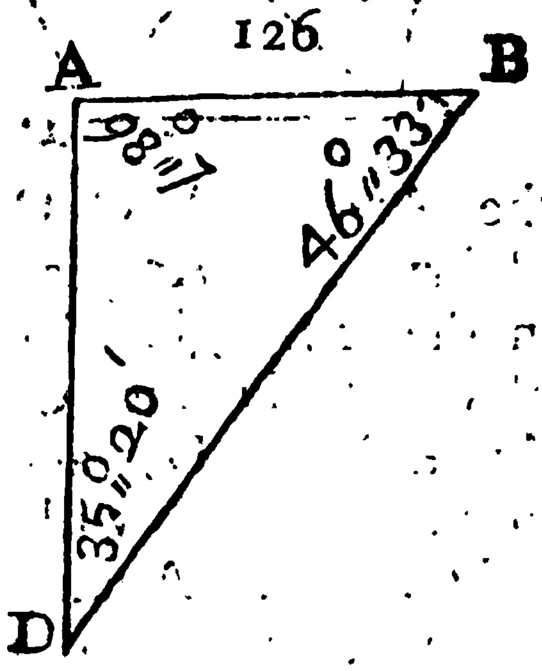
2. To measure Distances upon the Field, they commonly Use Mr. *Gunter*'s Chain, which contains 22 Yards in Length, the fourth Part of which is 5½ Yards, or 16½ Feet, is call'd a *Perch* or *Pole*; consequently

consequently a square Chain contains 16 square Poles, and since an Acre contains 10 square Chains, therefore 160 square Poles is equal to one Acre. This Chain is commonly divided into 100 equal Parts called *Links*, and is sometimes mark'd at every 10 Links for the Conveniency of working by Decimals.

Problem I.

To find the Distance of any Object from a given Point.

Let the Object be D, and the given Point A; then let the distance between A and any other Point B (from whence we can see the Object) be measur'd, and with a Semicircle, or any other proper Instrument, take the Angles D A B and A B D; then in the Triangle A B D are given the Angles and the Side A B, whence to find the Side A D it will be, by *Case 2d of Oblique Angled Trigonometry*,



S, D : AB :: S, B : A D.

Example. Suppose B A is 126 Feet; the Angle A 98°,, 7', the Angle B 46°,, 33' and consequently the Angle D 35°,, 20'; then for A D it will be

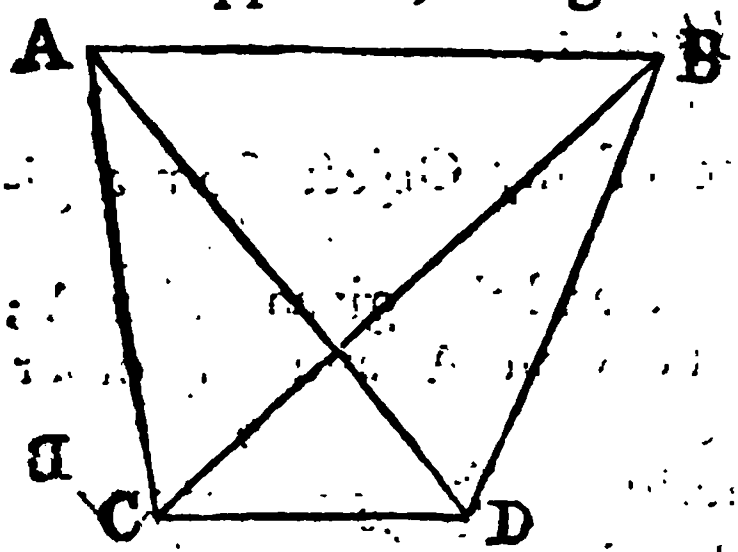
As the Sine of D - -	35°,, 20' -	9.76218
is to the distance A B -	126 - -	2.10037
so is the Sine of B - -	46°,, 33' -	9.86092
to the dist. between A and D	158.2 -	2.19911

Problem

Problem 2.

To find the Distance between two inaccessible Objects.

Let the two Objects be A and B, to which we cannot approach, being hinder'd by a River, *&c.*



assume in some convenient Place two Points C and D, from each of which you can see the two Objects, and measure the distance between them; then at the Point C observe the Angles A C D and D C B, and at D observe the Angles C D B and C D A; so in the Triangle C D B are given the two Angles B C D and C D B (and consequently the Angle C B D) and the Side C D; whence to find C B it will be S, C B D : S, C D B :: C D : C B. Again, in the Triangle A C D are given the two Angles A C D and A D C (and consequently the Angle C A D) and the Side C D, whence to find A C it will be S, C A D : S, C D A :: C D : C A. Lastly, from the Angle A C D take the Angle D C B, and there will remain the Angle A C B; then in the Triangle A C B are given the two Sides A C and C B, and the included Angle A C B, whence A B, the distance between the two Objects is found by *Case 5th of Oblique Trigonometry.*

Example.

Example. Suppose the Angle A C D is 94°,, 55′, the Angle B C D 41°,, 25′, the Angle C D B 103°,, 14′, the Angle A D C 46°,, 44′ and the Side C D 144 Feet: Then 1st for C B it will be

As the Sine of C B D -	35°,, 21′ -	9.76236
is to the Sine of C D B -	103,, 14 -	9.98831
so is C D - - - - - - -	144 - -	2.15836
to C B - - - - - - - -	242.3 - -	2.38431

2dly, For C A it well be

As the Sine of C A D - -	38°,, 21′ -	9.79256
is to the Sine of C D A -	46,, 44 -	9.86223
so is C D - - - - - - -	144 - -	2.15836
to C A - - - - - - - -	169.1 -	2.22803

Lastly, For A B it will be

As the Sum of the Sides A C and C B - - -	411.4 -	2.61426
is to their Difference - -	73.2 -	1.86451
so is the Tang. of ½ the Sum of the Ang. CAB and CBA	63°,, 15′ -	10.29753
to the Tang. of ½ their Diff.	19,, 26 -	9.54778

Then,

As the Sine of C B A -	43°,, 49′ -	9.84033
is to the Sine of A C B -	53,, 30 -	9.90518
so is A C - - - - - - - -	169.1 -	2.22803
to A B - - - - - - - -	196.3 -	2.29288

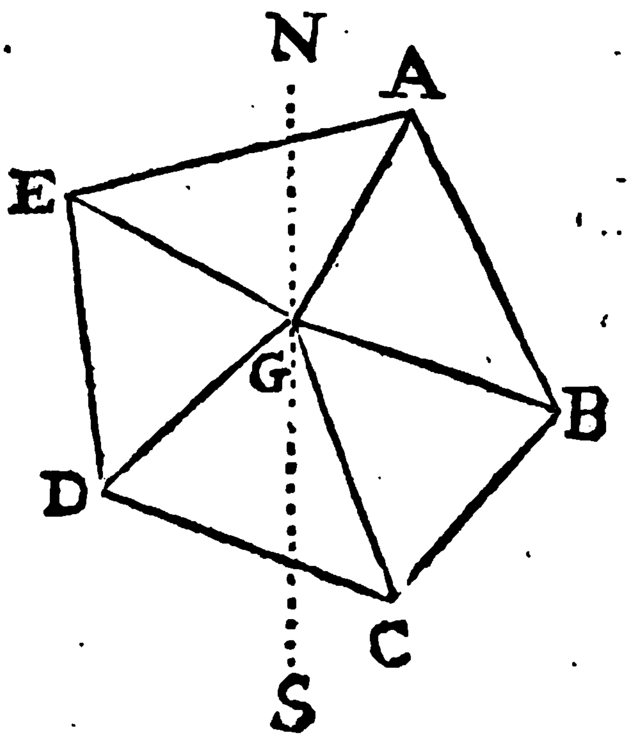
Consequently the Distance between the two Objects A and B is 196.3 Feet.

Problem 3.

To take the Plot of a Field at one Station, in or near the middle of it; when we can from thence see all the Angles or Corners of the Field.

This may either be done by the *Plain Table* or *Theodolite*, or any of the other Instruments above-mentioned.

Let ABCDE represent the Field; and first suppose you are to plot it with the Plain-Table: Having planted the Table with a Sheet of white Paper, fix'd upon it, in or near the middle of the Field, as at G; mark a Point upon the Paper to represent the Point of the Field on which the Table stands, and laying the Edge of your Index upon that Point, and keeping it there, turn it about so, as you can thro' the Sights see one of the Angles as A; then from the Point, along the edge of



the Index draw the Line G A, and measuring the Distance on the Field from the Plain-Table to the Angle at A in Chains and Links, take it from any convenient Line of equal Parts, and set it off upon the Paper, from G to A along the Line G A; then (keeping the Table still fix'd as it was) turn the Index so as it lying with its Edge upon the Point G, you may thro' the Sights see the Angle B, and drawing the Line G B, measure the Distance G B in the Field, which set off upon the Table from G to B; after the same manner drawing the Lines G C, G D and G E, and joining the extremities of them with the Right Lines A B, B C, C D, D E and E A, the Field is protracted, and the Lines B A, A E, &c. taken from the Scale from which you protract the rest, will give the Lengths of them in the Field.

To perform the same with the Theodolite, place the Instrument in, or near, the middle of the Field, as at G, and so as the Needle may hang directly over

over the Meridian Line of the Chard, which let N S represent; then direct your Sights from G to the Angle A, and observe the Number of Degrees it cuts, or the Bearing of A, which suppose to be N 16°,, 24′ E, and place this in the Field-Book, together with the Distance in Chains and Links from C to A, and proceeding the same way with the rest of the Angles, you'll have the bearing of each Angle from the Meridian, together with the Distance of each from the Instrument, in your Field-Book, the Form of which follows.

The FIELD-BOOK.

Angles	Bearings	Chains	Links	Remarks
A	N 16,, 24 E	7	20	
B	S 73,, 35 E	7	60	
C	S 19,, 15 E	7	65	
D	S 54,, 56 W	6	65	
E	N 59,, 40 W	7	26	

The Table is rul'd into five Columns; in the first are mark'd down the Angles express'd by Letters, or any other Characters at pleasure; the second contains the Bearings of these Angles from the Meridian; the third and fourth their Distances in Chains and Links from the place of Observation, and the fifth is for any remarkable Occurrence.

Having mark'd down the Bearings of all the Angles in the Field from the Meridian, together with their Distances in Chains from the place of Observation in your Field-Book, you may afterwards protract it upon Paper in the following manner, *viz.* Assume any convenient Point in the Paper to represent the place of Observation, and

 through

through it draw a Line repreſenting the Meridian; then from that Point draw Lines making Angles with the Meridian as in the Field-Book, and ſet off from the ſaid Point upon theſe Lines the ſeveral Diſtances expreſs'd in the Field-Book, taken from any Scale of equal Parts; laſtly, joining the Extremities of them with Right Lines, the Field will be protracted; and the Area of it in Chains may be found by *Prob.* 4. *Sect.* 15. which divided by 10 will give the Area in Acres.

The Method of plotting a Field by the *Semicircle*, *Circumferentor*, *&c.* differs ſo little from the way of doing the ſame by the Theodolite, that it would be altogether needleſs to ſhow it in each of them. When the Angles of the Field are at ſuch a Diſtance from you, that you can't perfectly perceive them from your Station; then put marks of white Paper, or pieces of Linnen at each of them, ſo as you may eaſily ſee them.

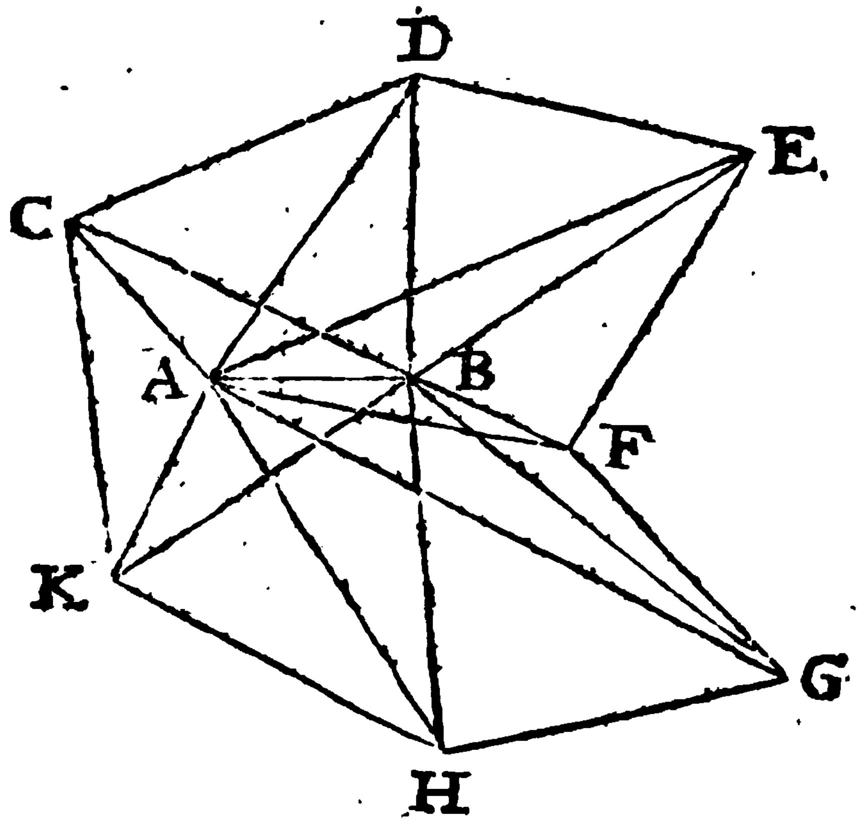
If it be more convenient to plot the Field at one Station in or near ſome corner of the Field; then you are to do it the ſame way by the Plain-Table, Theodolite, or any other of the Inſtruments, as when your Station was in or near the middle of the Field.

Problem 4.

To plot a Field at two Stations near the middle thereof, the Diſtance between which Stations is known, and from each of which all the Angles in the Field, can be eaſily ſeen.

Let the Field to be plotted be CDEFGHK, in which chuſe two convenient Points A and B near the middle, from each of which you can perceive all the Angles, and the Diſtance between which you know; then if you are to plot it by the *Plain-Table*,

Table, plant the Table upon the Point A, and mark a certain Point upon the Table to represent it, upon which lay the Edge of the Index, and direct the Sights to the other Station B, and by the Side of the Index draw A B; then from A along that Line set off a Line A B, taken from any convenient Scale of equal Parts, equal to the Distance between your two Stations; then laying



the edge of your Index upon the Point A, and directing your Sights to D, draw the Line A D; the same way keeping the Edge of the Index on A, direct the Sights to all the other Angles of the Field successively, and draw the Lines A E, A F, &c. then remove the Table to the other Station B, and laying the Edge of the Index along the Line A B, turn the Table about till you can thro' the Sights see the other Station A, and fixing the Table, lay the Edge of the Index on B, and direct the Sights to D, and draw the Line B D, which will intersect A D in D; the same way keeping the Edge of the Index still on the Point B, direct the Sights to all the other Angles of the Field, and draw the Lines B E, B F, &c. which will intersect the former Lines drawn from A in the Points E, F, G, &c. and joining these Points with Right

Right Lines, you'll have the Plot of the Field, and the Lines D E, E F, *&c.* taken from the same Scale of equal Parts that A B was taken from, will give the Distances of the Angles in the Field from one another. Lastly, The Area of the Field being thus protracted, may be found by *Prob.* 4. *of the last Section.*

In plotting of a Field at two Stations, you ought to take the Stations as far asunder as conveniently you can; for the nearer they are together, the more danger there is of contracting an Error, *& econtra.*

To plot the same by the Theodolite; having fix'd the Instrument in one of the Stations as A, turn it about till the Needle be directly over the Meridian Line of the Chard; then turn about the Index till you can through the Sights see the other Station B, and observe the bearing of it from the Meridian, and measure the Distance in Chains and Links, both which set down at the Head of the Field-Book. Thus

A B S 75°,, 23′ E——3 Chains 24 Links.

Then turn the Index to the Angle D, and observe its bearing from the Meridian, and the same way turning the Index to all the Angles of the Field, observe the bearing of each of them, which set down in the Field-Book in the second Column, mark'd at the top thus, *Station* A. Then go to the Station B, and fixing your Instrument as before, turn the Sights to the Angle D, and observe the bearing of it from the Meridian, and the same way turning the Sighes to the rest of the Angles, observe the bearing of each of them, which mark down in another Column of your Field-Book, mark'd at the top with *Station* B, and your Work in the Field is finish'd; the plotting of which upon Paper is so plain and easy that it needs no Example.

By this Method the principal Places in a Survey of a County, or any large Piece of Ground may be placed in a Map, *viz.* By making Choice of two Eminences for your two Stations, the Distance between which you can measure, and from each of which you can see all the principal Objects, such as *Churches*, *Castles*, *Hills*, *Gentlemens Seats*, and whatever else is remarkable in the Ground you are surveying.

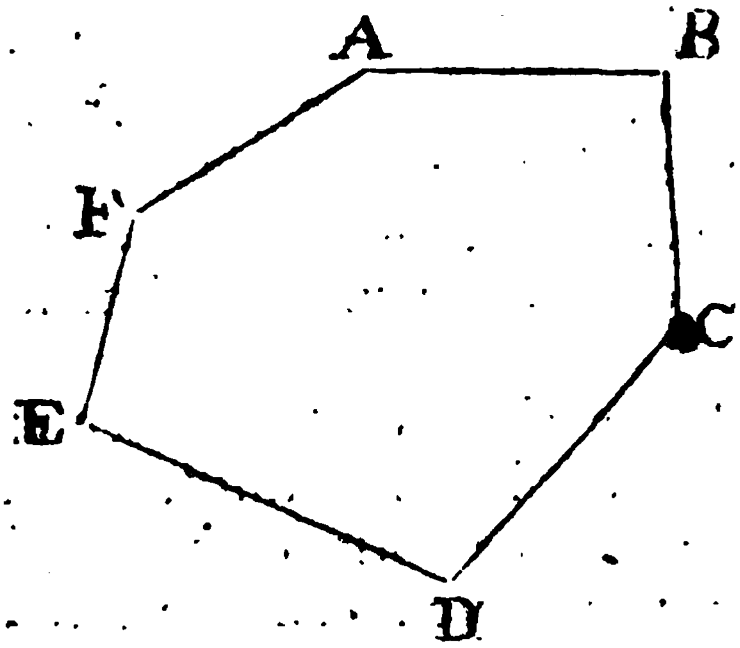
If all the Angles of the Field can't be seen at two Stations; then make Choice of a third, from whence you can see any of the former two, and the Distance between which you can measure; and if that be not sufficient, then use a 4th, 5th, *&c.* Station; by which means you'll always have two Stations to proceed with through the Country you are to survey, be it ever so large; and even in a Field where you can take the Survey of it at two Stations alone, the chusing a third Station from whence you can see one of the former ones, and also all the Angles of the Field, and thence taking the Plot of it as before, is a sure way of proving your former Work.

Problem 5.

To plot a Field by going round it.

Let the Field be ABCDEFA, and suppose you are to plot it by the Plain-Table. Having fix'd your Instrument at any of the Angles of the Field as A, mark a Point upon the Paper to represent it; then laying the Edge of the Index upon A, turn it about till through the Sights you can see the adjacent Angle F, and along the Edge of the Index draw the Line A F, which measure in the Field, and taking that from any Scale of equal Parts, set it off upon the Line A F on the Table

Table from A to F; then move your Table from A to F in the Field, and laying the Edge of the Index on F, turn it about till through the Sights you can see E, and draw the Line F E, which measure in the Field, and taking it from the same Scale, set it off upon the Table from F to E: after the same manner proceeding with the rest of the Angles you'll have the Plot of the Field.



To plot the same by the Theodolite. Having placed your Instrument at the corner of the Field, you are to begin from, as at A, set the Index at 00 Deg. 00 Min. then turn the Instrument about with that end of the Index forward (or towards F) that lies upon 00 Deg. 00 Min. till you can thro' the Sights see the Angle F; and there fixing the Instrument, turn the Index about till you can through the Sights see the corner B, and mark the Degrees (in your Field-Book) cut by the Index, which will be the measure of the Angle F A B, and measure A F in Chains and Links, which also mark down in your Field-Book; then remove your Instrument to F, and placing the Index upon the beginning of the Degrees as before, turn the Instrument about till you can thro' the Sights see the Corner A, and fixing the Instrument there, turn the Index about till you see thro' the Sights the Corner E, and mark the Degrees cut by the Index in your Field-Book, which will be the Angle A F E, then measure F E in Chains and Links, which also mark down in your Field Book: the same

same way proceeding with the rest of the Angles mark down the quantity of each, together with the Distance from the preceeding, in your Field-Book; and thence you may project it at leisure upon Paper.

This Method of plotting a Field by going round it, is much less liable to Error than any of the two former; and is more especially useful in measuring large Fields, or Fields upon which are Woods or other things to obstruct the Sight, in which Case the other Methods are impracticable.

SECT. XVII.

Of GAUGING.

1. WE have shewn in Section 16 how to find the Solidity of several sorts of Bodies, in Inches or Feet, *&c.* which Solidity (if taken in Inches) divided by the Inches contain'd in a Gallon, Bushel, *&c.* will shew the Number of Gallons, Bushels, *&c.* contain'd in the Vessel.

The Number of solid Inches contain'd in a Gallon, Bushel, *&c.* as determin'd by Act of Parliament, are as follows,

A Gallon of Ale or Beer	contains	282	Solid Inches
of Wine		231	
of Corn		268.8	
A Bushel of Malt		2150.4	
of Coals		2246.	
A Scots Pint		102.3	

2. In Gauging, the Veſſels that are not cylindrical are commonly reduc'd to Cylinders, and their Soliditys found as ſuch;

A *Cask* having different Diameters at the *Head* and *Bung*, is reduc'd to a Cylinder, by taking the mean or equated Diameter between the two for the Diameter of the Cylinder equal in Length and Solidity to the propos'd Cask; the common Method for finding the equated Diameter, and which ſerves pretty juſtly in moſt Casks, is this, *viz.* Multiply the Difference between the Head and Bung Diameters by .65; and adding the Product to the Head Diameter, the Sum will be the Diameter of a Cylinder of equal Length and Solidity with the Cask.

Hence we have the following Rule for finding the Content of any Cask in *Wine*, *Beer*, &c. The Head and Bung Diameter, and Length of the Cask being given in Inches. *viz.* Find the Equated Diameter between the Head and Bung Diameters of the Cask, and thence find the Area of the Circle belonging to that Diameter; then multiply this Area by the Length of the Cask, and the Product will be the Solidity of the Cask in Inches, which divided by the ſolid Inches contain'd in a Gallon of Wine, Beer, *&c.* will give the Content of the Cask in Wine, Beer, *&c.*

Example.

Let it be requir'd to find the Content of the Cask A E D B in Wine Gallons, whoſe Head Diameter A E or B D, is 26 Inches, the Bung Diameter F C 34 Inches, and the Length G H 55 Inches.

The Difference between the Head and Bung Diameters is 8 which multiply'd by .65, gives 5.2 and this added to 26 the Head Diameter makes 31.2 for

for the equated Diameter, or Diameter of the Cylinder equal in Length and Solidity with the propos'd Cask, the Area of whose Base is 764.539776, which multiply'd into 55 the Length, gives 42049.68768 for the Solidity in Inches; and this divided by 231 the solid Inches contain'd in a Gallon of Wine, gives 182.03328 for the Content of the propos'd Cask in Wine Gallons.

F

3. If the propos'd Cask be standing with its Axis perpendicular to the Horizon, and is not quite full of Liquor; then in order to find the Contents of the contain'd Liquor, you must find the equated Diameter, as above, and thence the Area of the Base of the Cylinder, the Cask is reduced to; which multiply'd into the Depth of the Liquor, will give the solid Content of the contain'd Liquor in Inches, and this divided by the Inches in a Gallon of Wine, Beer, *&c.* according to the Liquor contain'd, will give the Contents of the Liquor in the Cask.

This Rule more especially serves when the Cask is more than half full of Liquor; but when it is less than half full; then the Content of the contain'd Liquor is better found by subtracting the Content of the empty part of the Cask (found as above) from the Content of the whole, and the remainder will be the Content of the contain'd Liquor.

4. In Gauging, by the Area of any Surface in Wine *&c.* Gallons, is meant the Content of it at one Inch Depth. Consequently the Area of a Circle 1 Inch Diameter being .7854 this divided by

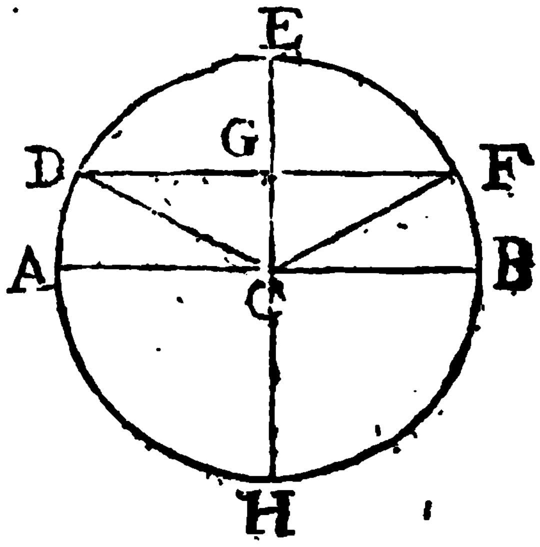
282 will give .002785 for the Content of that Circle 1 Inch Depth in Ale or Beer Gallons, and the same divided by 231 will give .0034 for its Content in Wine Gallons; and since Circles are to one another as the Squares of their Diameters; therefore, as 1 the Square of 1 Diameter, is to .0034 or .002785 the Area of that Circle in Wine or Ale Gallons, so is the square of the Diameter of any other Circle, to the Area of that Circle in Wine or Ale Gallons; hence since the first Term of the Proportion is Unity, it follows that the Area of any Circle in Wine or Ale Gallons is found by multiplying the Square of the Diameter by .0034 for Wine Gallons, and by .002785 for Ale Gallons, and this Area multiply'd into the Length of the Cask to which the Circle belongs, will give the Content of the Cask in Wine or Ale Gallons; and hence the two Numbers .0034 and .002785 are called *Fixt Multipliers.*

Again, If 1 be divided by the former Numbers .0034 and .002785, there will be produc'd their Reciprocals 294.12 and 359, with the first of which, dividing the Square of the Diameter of any Circle, the Quotient will be the Area of that Circle in Wine Gallons; and if the same be divided by the last, the Quotient will be the Area of that Circle in Ale Gallons; hence these two Numbers 294.12 and 359 are called *Fixt Divisors*, and in Practice are commonly made use of by the Gaugers.

5. When a *Cask* is lying upon its Side, with the Axis parallel to the *Horizon*, and is not full; but the Surface of the contain'd Liquor cuts the Heads of the Cask; then to find the Contents of the Liquor contain'd in the Cask, we must first know how to find the Area of any Segment of a given Circle. In order to which

Let AEBH represent a Circle, whose Diameter AB is 2; then (*by Cor.* 1. *Art.* 2. *Sect.* 15.) the Circum-

Circumference of that Circle will be 6.2832, and the Area 3.1416 (by *Prob.* 6. *Sect.* 15.) Hence 'tis evident that if the Diameter of a Circle be two Inches or Feet, &c. the Circumference of that Circle will contain twice as many Inches or Feet, &c. in Length, as the Area of it contains square Inches or Feet, &c. *i. e.* the Length of the Circumference is double the Area; and since the Area of the whole Circle, is to the Area of any Sector of it, as the Length of the whole Circumference, to the Length of the Arch of that Sector; it follows, that the Length of half the Arch of any Sector of a Circle whose Diameter is 2, is equal to the Area of that Sector. So in the annexed Scheme the Length of D E, half the Arch of the Sector D C F E will be the Area of that Sector.



In the annex'd Scheme, suppose G E (the versed Sine of half the Arch of the Sector D C F E) to be equal to .4; then since the Radius C E is 1, 'tis evident C G (the Right Line of D A, the Compliment of D E half the Arch of the Sector) will be equal to .6; so making it as 1, is to .6 or (to avoid Fractions) as 100, is to 60, so is the Radius of the Tables, to a fourth Number; this will be the Sine of A D, and looking in the Table we shall find it answer to 36.87 Degrees; the compliment of which, *viz.* 53.13 Deg. is the Arch D E; which multiply'd by .017453 the $\frac{1}{360}$ of 6.2832, gives .92727789 for the Length of the Arch D E, which is equal to the Area of the Sector D E F C.

Again, In the Right Angled Triangle C G D, 'tis evident (by *Cor.* 1. *Art.* 70. *Sect.* 1.) if from 1 the Square of C D we take .36 the square of C G

G, there will remain .64 the ſquare of D G, the ſquare Root of which, *viz.* .8 is equal to D G, and this doubled gives 1.6 equal to D F, which multiply'd into .3 the half of C G produces .48 for the Area of the Triangle D C F. Then from .92727789 for the Area of the Sector D C F E taking .48 the Area of the Triangle D C F, there will remain .44727789 for the Area of the Segment D E F D, and this taken from 3.1416, the Area of the whole Circle there will remain 2.69432211 for the Area of the other Segment D H F D whoſe verſed Sine is 1.6.

After the ſame manner, by dividing the Diameter of the Circle, *viz.* 2, into 100, or any other Number of equal Parts, we may find the Area of the Segment anſwering to each verſed Sine.

Having by the foregoing Method, found the Area of a Segment belonging to any verſed Sine in that Circle whoſe Diameter is 2, and Area 3.1416; we may find the Area of the ſimilar Segment in any other Circle by the following Analogy, *viz.*

As the Area of that Circle whoſe Diameter is 2, *viz.* 3.1416, is to the Segment belonging to any part of its Diameter, ſo is the Area of any other Circle, to the Segment belonging to the like part of its Diameter.

And hence ariſes the Conſtruction of the following Table.

A TABLE

A Table of the Segments of a Circle, whose Area is 1 the Diameter, (*viz.* 1.128378) being divided into 100 equal Parts.

V	Segm.	V	Segm.	V	Segm.	V	Segm.	V	Segm.
1	.0017	21	.1526	1	.3860	61	.6389	81	.8677
2	.0048	22	.1631	2	.3986	62	.6514	82	.8776
3	.0087	23	.1738	3	.4112	63	.6636	83	.8873
4	.0134	24	.1845	4	.4238	64	.6759	84	.8968
5	.0187	25	.1955	5	.4365	65	.6881	85	.9059
6	.0245	26	.2066	6	.4491	66	.7002	86	.9149
7	.0308	27	.2178	7	.4618	67	.7122	87	.9236
8	.0375	28	.2292	8	.4745	68	.7241	88	.9320
9	.0446	29	.2407	9	.4873	69	7360	89	.9402
10	.0520	30	.2523	0	.5000	70	7477	90	.9480
11	.0598	31	.2640	1	.5127	71	.7593	91	.9554
12	.0680	32	.2759	2	.5255	72	.7708	92	.9625
13	.0764	33	.2878	3	.5382	73	.7822	93	.9692
14	.0851	34	.2998	4	.5509	74	.7934	94	.9755
15	.0941	35	.3119	5	.5635	75	.8045	95	.9813
16	.1032	36	.3241	[illegible]	.5762	76	.8155	96	.9866
17	.1127	37	.3364	[illegible]	.5888	77	.8262	97	.9913
18	.1224	38	.3486	[illegible]	.6014	78	.8369	98	.9952
19	.1323	39	.3611	[illegible]	.614	79	.8474	99	.9983
20	.1424	40	.3735	[illegible]	.6265	80	.8576	100	1.0000

In this Table you may obſerve that the Columns mark'd at the Top with V, contain the verſed Sines, proceeding from 1 to 100, and the adjacent Columns contain the Areas of the Segments belonging to theſe verſed Sines.

By this Table the Content of the Liquor contain'd in a Cask not full, lying with its Axis parallel to the Horizon and the contain'd Liquor cutting the Heads of the Cask; may be found after the following manner, *viz.*

To the wet Inches of the Bung Diameter, add a competent Number of Cyphers, and divide this by

by the whole Diameter, then seek for the Quotient in the Columns mark'd V at the Top in the preceeding Table, and opposite to this in the adjacent Column you'll find the Area of a Segment, which multiply into the whole Content of the Cask, and the Product is the Content of the Liquor in the Cask. If instead of the wet Inches we had us'd the dry, then the last Product would have been the Content of the empty part of the Cask, which is call'd the *Ullage.*

Example.

Suppose a Cask lying with its Axis parallel to the Horizon, has a certain Quantity of Wine in it, the Bung Diameter is 32 Inches, the Head Diameter 28, the Length 48 and the wet Inches 20. Requir'd the Content of the Liquor.

To the wet Inches 20 I add a number of Cyphers, and dividing it by 32 I find the Quotient .66, which I look for in the Table and find it answer to the Segment .7002, which multiply'd by 152.8 the whole Content of the Cask in Wine Gallons (found by *Art.* 2. of this *Sect.*) gives 107 for the Content of the Liquor in the Cask, in Wine Gallons.

6. Malt when lying on a Floor is gaug'd by taking the Depth of it in Inches, in several Places, and dividing the Sum of these Depths by the Number of them, the Quotient will be the mean Depth; which multiply'd into the Area of the Surface gives the Solidity in Inches; and this divided by 2150.4 gives the Content in Bushels.

7. Solid Timber is measur'd by the solid Foot, each containing 1728 solid Inches; the common way is this, *viz.* Girth the Tree in several Places and take $\frac{1}{4}$ of the mean Girth in Inches, for the Side of a Square; which Square multiply into the Length

Length of the Tree, and the Product will be the Solidity in Inches, and this divided by 1728, will give the Solidity of the Tree in Feet.

8. The Solidity of irregular Bodies may be found exactly, after the following Method, *viz.* Let the Body be immers'd in Water in a Parallelipiped, whose Sides are exactly divided into Inches and the Solidity of the Water rais'd, will be equal to the Solidity of the immers'd Body.

9. The common Rule for finding the Tunnage of a Ship is as follows.

Multiply the Length of the Keel by the Breadth, and the Product by half the Breadth; then divide this last Product by 95, and the Quotient will give the Tunnage.

Example.

Suppose a Ship's Keel is 135 Feet, and her Breadth from out to out, 48 Feet. Requir'd the Tunnage of that Ship.

The Length of the Keel, *viz.* 135 multiply'd into the Breadth 48, produces 6480, and this multiply'd into 24, half the Breadth, gives 155520, which last divided by 95, the Quotient is 1637 the Tunnage of the propos'd Ship.

FINIS.

A TABLE *of the Latitudes and Longitudes of some of the most principal Harbours, Headlands, and Islands, in the most frequented Parts of the World; the Longitude being counted from the Meridian of* LONDON.

Places Names	Lat. D.	Lat. M.		Long. D.	Long. M.	Denom.
The Coast of *England*						
BERWICK - -	55	50	Latitude North	01	39	W
Newcastle - - -	54	58		01	30	W
Scarborough - - - - -	54	20		01	20	W
Stockton - - - - - -	54	33		01	25	W
Flamborough-Head - -	54	08		00	11	E
Yarmouth - - - - -	52	45		01	40	E
Ipswich - - - - - -	52	14		01	00	E
Colchester - - - - - -	52	04		00	58	E
LONDON - - -	51	32		00	00	
The *Downs* - - - -	51	25		01	21	E
Dover - - - - - -	51	15		01	18	E
Beachy - - - - - - -	50	48		00	25	E
Portsmouth - - - - -	50	48		01	00	W
Dartmouth - - - - -	50	27		03	36	W
Plymouth - - - - -	50	36		04	13	W
Lizard - - - - - - -	50	00		05	14	W
Bristol - - - - - -	51	32		02	35	W
Liverpool - - - - -	53	20		03	10	W
White-Haven - - -	54	10		03	50	W
The Coast of *Scotland*						
Glasgow - - - - - -	55	53		04	05	W
Aberdeen - - - - - -	57	24		01	37	W
Leith - - - - - - - -	56	00		02	55	W
St. Kilda - - - - - -	58	02		10	05	W
Cat-Ness - - - - - -	58	47		02	06	W
Buchan-Ness - - - - -	57	55		01	20	W
Orkney Isles - - - - -	59	13		03	32	W

Places Names	Lat.			Long.		Denom.
Coast of *Ireland*	D.	M.		D.	M.	
London-Derry - - -	55	05	Latitude North	08	00	W
Belfast - - - - - -	54	36		06	50	W
Cork - - - - - - -	51	49		09	30	W
Cape-Clear - - - - -	51	10		10	30	W
Lambay - - - - - -	53	24		07	30	W
Dublin - - - - - -	53	12		06	55	W
Coast of *Holland* and *Flanders*						
Hamborough - - - - -	53	41		10	25	E
Bremen - - - - - -	53	50		08	00	E
The *Texel* - - - - -	53	10		04	59	E
Amsterdam - - - - -	52	21		04	51	E
Roterdam - - - - - -	51	55		04	21	E
Dunkirk - - - - - -	51	14		02	20	E
Calais - - - - - - -	50	57		01	55	E
On the Coast of *France* and *Portugal*						
Guernsey - - - - - -	49	36		02	40	W
Jersey - - - - - -	49	20		02	19	W
Rochel - - - - - -	46	10		01	14	W
Bourdeaux - - - - -	44	50		00	24	W
Bilboa - - - - - -	43	30		03	00	W
Porta Port - - - - -	41	18		09	20	W
Cadiz - - - - - - -	36	20		06	28	W
Coast on the main Continent within the *Straits*, and on the Coast of *Spain*, &c.						
Gibraltar - - - - - -	36	11		05	20	W
Malaga - - - - - -	36	50		03	17	W
Barcelona - - - - -	41	26		02	26	E
Marseilles - - - - -	43	20		05	27	E
Toulon - - - - - -	43	06		05	40	E

Places Names	Lat. D.	Lat. M.		Long. D.	Long. M.	Den.
Genoa	44	27	North Latitude	09	06	E
Legborne	43	18		10	44	E
Rome	41	51		13	05	E
Naples	41	05		15	40	E
Gallipoli	40	08		18	42	E
Venice	45	18		12	40	E
Constantinople	41	07		31	45	E
Smyrna	38	28		27	20	E
Scanderoon	36	00		35	58	E
Tripoli	34	40		35	48	E
Alexandria	31	07		33	00	E
Algier	36	40		03	05	E
Coast of *Barbary* and *Guinea*, &c.						
Sallee	33	43		06	30	W
Cape de Verde	14	30		16	26	W
River *Gambia*	13	16		15	20	W
Monserado	06	05		09	20	W
Cape Corce	04	40		03	10	E
Cape Formosa	04	40		08	00	E
River *Congo*	05	45	S. Lat.	15	27	E
Angela	08	51		15	56	E
C. St. Thomas	23	10		14	23	E
Cape of good Hope	34	15		17	00	E
Western Islands						
Corvo	40	05	North Lat.	31	55	W
Fyal	39	32		31	52	W
Pico	38	45		28	34	W
Gratiosa	39	30		28	15	W
St. Michael	37	50		24	52	W
St. Maries	37	00		22	17	W
Porto Sancto	32	45		16	05	W
Madera West End	32	20		17	30	W

Places Names	Lat.			Long.		Den.
	D.	M.	North Latitude	D.	M.	West Longitude
Teneriff - - -	27	50		17	05	
Canary - - -	27	40		16	10	
St. Antonio - -	17	20		24	50	
Fuego - - -	15	00		24	05	
Jago - - -	15	10		23	30	
St. Lucia - - -	17	20		24	00	
St. Nicholas - -	17	12		23	30	
St. Vincent - -	17	10		24	20	
Antegoa - - -	17	30		60	40	
Barbadoes - -	13	30		58	10	
Berbuda - - -	17	58		60	40	
St. Cruz - - -	18	00		63	25	
Coast of *Carolina*, *Virginia*, *Maryland*, &c.						
Charles Town on *Ashly* River	32	40		78	50	
Cape Henry . .	37	00		74	25	
Quebeck . . .	47	15		68	10	
New York . . .	41	00		72	05	
Boston - - -	42	35		68	50	
Trinity Bay - -	48	27		52	15	
Cape St. Mary . .	47	10		53	20	
Placentia - - -	47	57		53	00	
Cape Charles - -	37	14		74	15	
St. John's Harbour - -	47	28		51	23	
Coast of *Hudson's Bay*, and the *Straits*.						
Cape Jones	55	03		78	56	
Albany River	51	16		79	44	
Shark Point . - .	64	27		83	16	
Button's Isle . .	60	05		66	50	
Cape Charles - - - -	62	35		74	36	
Port Nelson . .	57	10		92	50	

Places Names	Lat. D.	Lat. M.		Long. D.	Long. M.	Den.
Coaſt of *America* in the *South-Sea*						
C. St. Sebaſtian - - -	42	40	N. Lat.	129	40	West Longitude
Panama - - -	08	56		82	18	
Aquatulco - - - - -	15	27		101	03	
Cape St. Luca - - - -	23	25		111	56	
Cape del Ajugo - - -	16	38	South Latitude	88	50	
Arica - - -	18	12		74	07	
Baldivia - - -	39	35		81	18	
Cape Victory - -	52	15		82	56	
Cape Horn - -	57	58		79	44	
Coaſt of *Brazil* in S. *America*						
River *Julian* - -	48	40		74	32	
Cape Blanco . .	46	50		72	05	
St. Katherine's Iſle .	28	00		47	50	
Cape Frio - - -	23	10		42	56	
Cape Roque - -	05	00		35	52	
Coaſt on the main Continent in the *Weſt-Indies*						
North Cape . . .	02	05	North Latitude	49	55	
Surnam	06	00		56	44	
Carthagena	10	50		75	50	
Campeche . . .	19	20		93	05	
Portobello . . .	09	55		80	15	
La vera Cruz . .	19	15		100	22	
Cape Florida . .	24	48		81	55	
Southern Iſlands						
Aſcenſion	07	40	S	14	50	
St. Helena	16	06	S	06	30	
St. Matthew's . -	01	40	S	07	50	
Princeps . . .	01	35	N	09	03	E
St. Thomas . . .	00	00		08	00	E
Annabona	01	05	S	07	30	E

Places Names	Lat. D.	Lat. M.		Long. D.	Long. M.	
Coast of the *East-Indies*						
Mosambique	15	05	S	40	30	
River *de Fugos* . . .	00	00		41	15	
Cape de Bassus . . .	04	00		44	50	
Surrat . . .	21	08		73	25	
Siam Entrance . . .	13	10		101	01	
Goa	15	30	Lat. North	73	50	
Fort St. George - - -	13	08		81	34	
Dew Point - - -	15	50		81	50	
Bengal . . .	22	27		91	49	
Malacca	23	32		105	05	
Cambodia	10	30		104	20	
Nanquim . . .	32	55		129	30	
Islands in the *East-Indies*.						
Abdeleur	12	27	N	52	35	East Longitude
Almircant Isles, the Eastermost	03	42	S	52	20	
Bantam in *Javes* . . .	05	37	S	105	11	
Batavia . . .	05	47	S	106	27	
Babelmandel, in the Mouth of the *Red Sea*	12	25	N	45	45	
Borneo	04	20	S	109	50	
Good Fortune . . .	01	28	S	97	20	
Java, East-End . . .	06	20	S	113	37	
Japan, S. East Point .	34	30	N	135	35	
——---- S. West Point .	35	20	N	126	50	
Joanna . . .	12	10	S	41	20	
Printes Isle	05	47	S	105	11	
Zocatra	12	28	N	54	20	
Madagascar, South End of *St. Sebastian* .	25	32	S	74	15	
Coast of the *Sound* and *Baltick Sea*						
Gottenberg	57	33	N	12	25	
Christiana - - -	59	10	N	9	45	

Places Names	Lat. D.	Lat. M.	North Latitude	Long. D.	Long. M.	East Latitude
Elsinore	56	00		12	32	
Cophenhagen	55	40		12	30	
Stockholm	59	20		18	25	
Vyburgh	60	20		29	26	
Petersburgh	59	24		29	50	
Riga	56	50		24	50	
Coningsberg	55	00		20	13	
Dantzick	54	22		19	10	
Scaw	57	26		10	14	
Coast from the *Naze* of *Norway* to *Archangel*						
Naze of *Norway*	57	50		07	22	
Dronton	64	00		10	40	
North Cape	71	25		22	10	
Standland	62	10		04	38	
Kilduyn	69	32		30	12	
Archangel-Bar	64	30		40	30	
Cross Island	66	31		36	10	
Coast of the Northern *Islands*, *Nova Zembla*, *Iceland*, and *Greenland*.						
Bear Isle	74	35		18	12	
Hope Isle	76	13		21	44	
Catsnose	65	44		33	13	
Point Lookout	76	40		16	25	
Horn Sound	77	30		13	56	
Grims Island	66	43		17	45	
Whales Back	65	27		10	05	
Sound Royal	66	20		14	12	

A Table

A

TABLE

OF

LOGARITHMS,

For NUMBERS increasing in their Natural Order from Unity to 10000.

a

A Table of Logarithms.

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
1	0.00000	46	1.66276	91	1.95904	136	2.13354
2	0.30103	47	1.67210	92	1.96379	137	2.13672
3	0.47712	48	1.68124	93	1.96848	138	2.13988
4	0.60206	49	1.69020	94	1.97313	139	2.14301
5	0.69897	50	1.69897	95	1.97772	140	2.14613
6	0.77815	51	1.70757	96	1.98227	141	2.14922
7	0.84510	52	1.71600	97	1.98677	142	2.15229
8	0.90309	53	1.72428	98	1.99123	143	2.15534
9	0.95424	54	1.73239	99	1.99564	144	2.15836
10	1.00000	55	1.74036	100	2.00000	145	2.16137
11	1.04139	56	1.74819	101	2.00432	146	2.16435
12	1.07918	57	1.75587	102	2.00860	147	2.16732
13	1.11394	58	1.76343	103	2.01284	148	2.17026
14	1.14613	59	1.77085	104	2.01703	149	2.17319
15	1.17609	60	1.77815	105	2.02119	150	2.17609
16	1.20412	61	1.78533	106	2.02531	151	2.17898
17	1.23045	62	1.79239	107	2.02938	152	2.18184
18	1.25527	63	1.79934	108	2.03342	153	2.18469
19	1.27875	64	1.80618	109	2.03743	154	2.18752
20	1.30103	65	1.81291	110	2.04139	155	2.19033
21	1.32222	66	1.81954	111	2.04532	156	2.19312
22	1.34242	67	1.82607	112	2.04922	157	2.19590
23	1.36173	68	1.83251	113	2.05308	158	2.19866
24	1.38021	69	1.83885	114	2.05690	159	2.20140
25	1.39794	70	1.84510	115	2.06071	160	2.20412
26	1.41497	71	1.85126	116	2.06446	161	2.20683
27	1.43136	72	1.85733	117	2.06819	162	2.20952
28	1.44716	73	1.86332	118	2.07188	163	2.21219
29	1.46240	74	1.86923	119	2.07555	164	2.21484
30	1.47712	75	1.87506	120	2.07918	165	2.21748
31	1.49136	76	1.88081	121	2.08279	166	2.22011
32	1.50515	77	1.88649	122	2.08636	167	2.22272
33	1.51851	78	1.89209	123	2.08991	168	2.22531
34	1.53148	79	1.89762	124	2.09342	169	2.22789
35	1.54407	80	1.90309	125	2.09691	170	2.23045
36	1.55630	81	1.90849	126	2.10037	171	2.23300
37	1.56820	82	1.91381	127	2.10380	172	2.23553
38	1.57978	83	1.91908	128	2.10721	173	2.23805
39	1.59106	84	1.92428	129	2.11059	174	2.24055
40	1.60206	85	1.92942	130	2.11394	175	2.24304
41	1.61278	86	1.93450	131	2.11727	176	2.24551
42	1.62325	87	1.93952	132	2.12057	177	2.24797
43	1.63347	88	1.94448	133	2.12385	178	2.25042
44	1.64345	89	1.94939	134	2.12710	179	2.25285
45	1.65321	90	1.95424	135	2.13033	180	2.25527

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
181	2.25768	226	2.35411	271	2.43297	316	2.49969
182	2.26007	227	2.35603	272	2.43457	317	2.50106
183	2.26245	228	2.35793	273	2.43616	318	2.50243
184	2.26482	229	2.35984	274	2.43775	319	2.50379
185	2.26717	230	2.36173	275	2.43933	320	2.50515
186	2.26951	231	2.36361	276	2.44091	321	2.50651
187	2.27184	232	2.36549	277	2.44248	322	2.50786
188	2.27416	233	2.36736	278	2.44404	323	2.50920
189	2.27646	234	2.36922	279	2.44560	324	2.51055
190	2.27875	235	2.37107	280	2.44716	325	2.51188
191	2.28103	236	2.37291	281	2.44871	326	2.51322
191	2.28330	237	2.37475	282	2.45025	327	2.51455
193	2.28556	238	2.37658	283	2.45179	328	2.51587
194	2.28780	239	2.37840	284	2.45332	329	2.51720
195	2.29003	240	1.38021	285	2.45484	330	2.51851
196	2.29226	241	2.38202	286	2.45637	331	2.51983
197	2.29447	242	2.38382	287	2.45788	332	2.52114
198	2.29667	243	2.38561	288	2.45939	333	2.52244
199	2.29885	244	2.38739	289	2.46090	334	2.52375
200	2.30103	245	2.38917	290	2.46240	335	2.52504
201	2.30320	246	2.39094	291	2.46389	336	2.52634
202	2.30535	247	2.39270	292	2.46538	337	2.52763
203	2.30750	248	2.39445	293	1.46687	338	2.52892
204	2.30963	249	2.39620	294	2.46835	339	2.53020
205	2.31175	250	2 39794	295	2.46982	340	2.53148
206	2.31387	251	2.39967	296	2.47129	341	2.53275
207	2.31597	252	2.40140	297	2.47276	342	2.53403
208	2.31806	253	2.40312	298	2.47422	343	2.53529
209	2.32015	254	2.40483	299	2.47567	344	2.53656
210	2.32222	255	2.40654	300	2.47712	345	2.53782
211	2.32428	256	2.40824	301	2.47857	346	2.53908
212	2.32634	257	2.40993	302	2.48001	347	2.54033
213	2.32838	258	2.41162	303	2.48144	348	2.54158
214	2.33041	259	2.41330	304	2.48287	349	2.54283
215	2.33244	260	2.41497	305	2.48430	350	2.54407
216	2.33445	261	2.41664	306	2.48572	351	2.54531
217	2.33646	262	2.41830	307	2.48714	352	2.54654
218	2.33846	263	2.41996	308	2.48855	353	2.54777
219	2.34044	264	2.42160	309	2.48996	354	2.54900
220	2.34242	265	2.42325	310	2.49136	355	2.55023
221	2.34439	266	2.42488	311	2.49276	356	2.55145
222	2.34635	267	2.42651	312	2.49415	357	2.55267
223	2.34830	268	2.42813	313	2.49554	358	2.55388
224	2.35025	269	2.42975	314	2.49693	359	2.55509
225	2.35218	270	2.43136	315	2.49831	360	2.55630

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
541	2.73320	586	2.76790	631	2.80003	676	2.82995
542	2.73400	587	2.76864	632	2.80072	677	2.83059
543	2.73480	588	2.76938	633	2.80140	678	2.83123
544	2.73560	589	2.77012	634	2.80209	679	2.83187
545	2.73640	590	2.77085	635	2.80277	680	2.83251
546	2.73719	591	2.77159	636	2.80346	681	2.83315
547	2.73799	592	2.77232	637	2.80414	682	2.83378
548	2.73878	593	2.77305	638	2.80482	683	2.83442
549	2.73957	594	2.77379	639	2.80550	684	2.83506
550	2.74036	595	2.77452	940	2.80618	685	2.83569
551	2.74115	596	2.77525	641	2.80686	686	2.83632
552	2.74194	597	2.77597	642	2.80754	687	2.83696
553	2.74273	598	2.77670	643	2.80821	688	2.83759
554	2.74351	599	2.77743	644	2.80889	689	2.83822
555	2.74429	600	2.77815	645	2.80956	690	2.83885
556	2.74507	601	2.77887	646	2.81023	691	2.83948
557	2.74586	602	2.77960	647	2.81090	692	2.84011
558	2.74663	603	2.78032	648	2.81158	693	2.84073
559	2.74741	604	2.78104	649	2.81224	694	2.84136
560	2.74819	605	2.78176	650	2.81291	695	2.84198
561	2.74896	606	2.78247	651	2.81358	696	2.84261
562	2.74974	607	2.78319	652	2.81425	697	2.84323
563	2.75051	608	2.78390	653	2.81491	698	2.84386
564	2.75128	609	2.78462	654	2.81558	699	2.84448
565	2.75205	610	2.78533	655	2.81624	700	2.84510
566	2.75282	611	2.78604	656	2.81690	701	2.84572
567	2.75358	612	2.78675	657	2.81757	702	2.84634
568	2.75435	613	2.78746	658	2.81823	703	2.84696
569	2.75511	614	2.78817	659	2.81889	704	2.84757
570	2.75587	615	2.78888	660	2.81954	705	2.84819
571	2.75664	616	2.78958	661	2.82020	706	2.84880
572	2.75740	617	2.79029	662	2.82086	707	2.84942
573	2.75815	618	2.79099	663	2.82151	708	2.85003
574	2.75891	619	2.79169	664	2.82217	709	2.85065
575	2.75967	620	2.79239	665	2.82282	710	2.85126
576	2.76042	621	2.79309	666	2.82347	711	2.85187
577	2.76118	622	2.79379	667	2.82413	712	2.85248
578	2.76193	623	2.79449	668	2.82478	713	2.85309
579	2.76268	624	2.79518	669	2.82543	714	2.85370
580	2.76343	625	2.79588	670	2.82607	715	2.85431
581	2.76418	626	2.79657	671	2.82672	716	2.85491
582	2.76492	627	2.79727	672	2.82737	717	2.85552
583	2.76567	628	2.79796	673	2.82802	718	2.85612
584	2.76641	629	2.79865	674	2.82866	719	2.85673
585	2.76716	630	2.79934	675	2.82930	720	2.85733

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
721	2.85794	766	2.88423	811	2.90902	856	2.93247
722	2.85854	767	2.88480	812	2.90956	857	2.93298
723	2.85914	768	2.88536	813	2.91009	858	2.93349
724	2.85974	769	2.88593	814	2.91062	859	2.93399
725	2.86034	770	2.88649	815	2.91116	860	2.93450
726	2.86094	771	2.88705	816	2.91169	861	2.93500
727	2.86153	772	2.88762	817	2.91222	862	2.93551
728	2.86213	773	2.88818	818	2.91275	863	2.93601
729	2.86273	774	2.88874	819	2.91328	864	2.93651
730	2.86332	775	2.88930	820	2.91381	865	2.93702
731	2.86392	776	2.88986	821	2.91434	866	2.93752
732	2.86451	777	2.89042	822	2.91487	867	2.93802
733	2.86510	778	2.89098	823	2.91540	868	2.93852
734	2.86570	779	2.89154	824	2.91593	869	2.93902
735	2.86629	780	2.89209	825	2.91645	870	2.93952
736	2.86688	781	2.89265	826	2.91698	871	2.94002
737	2.86747	782	2.89321	827	2.91751	872	2.94052
738	2.86806	783	2.89376	828	2.91803	873	2.94101
739	2.86864	784	2.89432	829	2.91855	874	2.94151
740	2.86923	785	2.89487	830	2.91908	875	2.94201
741	2.86982	786	2.89542	831	2.91960	876	2.94250
742	2.87040	787	2.89597	832	2.92012	877	2.94300
743	2.87099	788	2.89653	833	2.92065	878	2.94349
744	2.87157	789	2.89708	834	2.92117	879	2.94399
745	2.87216	790	2.89763	835	2.92169	880	2.94448
746	2.87274	791	2.89818	836	2.92221	881	2.94498
747	2.87332	792	2.89873	837	2.92273	882	2.94547
748	2.87390	793	2.89927	838	2.92324	883	2.94596
749	2.87448	794	2.89982	839	2.92376	884	2.94645
750	2.87506	795	2.90037	840	2.92428	885	2.94694
751	2.87564	796	2.90091	841	2.92480	886	2.94743
752	2.87622	797	2.90146	842	2.92531	887	2.94792
753	2.87680	798	2.90200	843	2.92583	888	2.94841
754	2.87737	799	2.90255	844	2.92634	889	2.94890
755	2.87795	[illegible]	[illegible]	845	2.92686	890	2.94939
756	2.87852	[illegible]	[illegible]	846	2.92737	891	2.94988
757	2.87910	[illegible]	[illegible]	847	2.92788	892	2.95036
758	2.87967	[illegible]	[illegible]	848	2.92840	893	2.95085
759	2.88024	[illegible]	[illegible]	849	2.92891	894	2.95134
760	2.88081	[illegible]	[illegible]	850	2.92942	895	2.95182
761	2.88138	806	2.90634	851	2.92993	896	2.95231
762	2.88196	807	2.90687	852	2.93044	897	2.95279
763	2.88252	808	2.90741	853	2.93095	898	2.95328
764	2.88309	809	2.90795	854	2.93146	899	2.95376
765	2.88366	810	2.90849	855	2.93197	900	2.55424

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
901	2.95472	946	2.97589	991	2.99607	1036	3.01536
902	2.95521	947	2.97635	992	2.99651	1037	3.01578
903	2.95569	948	2.97681	993	2.99695	1038	3.01620
904	2.95617	949	2.97727	994	2.99739	1039	3.01662
905	2.95665	950	2.97772	995	2.99782	1040	3.01703
906	2.95713	951	2.97818	996	2.99826	1041	3.01745
907	2.95761	952	2.97864	997	2.99870	1042	3.01787
908	2.95809	953	2.97909	998	2.99913	1043	3.01828
909	2.95856	954	2.97955	999	2.99957	1044	3.01870
910	2.95904	955	2.98000	1000	3.00000	1045	3.01912
911	2.95952	956	2.98046	1001	3.00043	1046	3.01953
912	2.95999	957	2.98091	1002	3.00087	1047	3.01995
913	2.96047	958	2.98137	1003	3.00130	1048	3.02036
914	2.96095	959	2.98182	1004	3.00173	1049	3.02078
915	2.96142	960	2.98227	1005	3.00217	1050	3.02119
916	2.96190	961	2.98272	1006	3.00260	1051	3.02160
917	2.96237	962	2.98318	1007	3.00303	1052	3.02202
918	2.96284	963	2.98363	1008	3.00346	1053	3.02243
919	2.96332	964	2.98408	1009	3.00389	1054	3.02284
920	2.96379	965	2.98453	1010	3.00432	1055	3.02325
921	2.96426	966	2.98498	1011	3.00475	1056	3.02366
922	2.96473	967	2.98543	1012	3.00518	1057	3.02408
923	2.96520	968	2.98588	1013	3.00561	1058	3.02449
924	2.96567	969	2.98632	1014	3.00604	1059	3.02490
925	2.96614	970	2.98677	1015	3.00647	1060	3.02531
926	2.96661	971	2.98722	1016	3.00689	1061	3.02572
927	2.96708	972	2.98767	1017	3.00732	1062	3.02613
928	2.96755	973	2.98811	1018	3.00774	1063	3.02653
929	2.96806	974	2.98856	1019	3.00817	1064	3.02694
930	2.96848	975	2.98900	1020	3.00860	1065	3.02735
931	2.96895	976	2.98945	1021	3.00903	1066	3.02776
932	2.96942	977	2.98989	1022	3.00945	1067	3.02816
933	2.96988	978	2.99034	1023	3.00988	1068	3.02857
934	2.97035	979	2.99078	1024	3.01030	1069	3.02898
935	2.97081	980	2.99123	1025	3.01072	1070	3.02938
936	2.97128	981	2.99167	1026	3.01115	1071	3.02979
937	2.97174	982	2.99211	1027	3.01157	1072	3.03019
938	2.97220	983	2.99255	1028	3.01199	1073	3.03060
939	2.97267	984	2.99300	1029	3.01242	1074	3.03100
940	2.97313	985	2.99344	1030	3.01284	1075	3.03141
941	2.97359	986	2.99388	1031	3.01326	1076	3.03181
942	2.97405	987	2.99432	1032	3.01368	1077	3.03222
943	2.97451	988	2.99476	1033	3.01410	1078	3.03262
944	2.97497	989	2.99520	1034	3.01452	1079	3.03302
945	2.97543	990	2.99564	1035	3.01494	1080	3.03342

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
1081	3.03383	1126	3.05154	1171	3.06856	1216	3.08493
1082	3.03423	1127	3.05192	1172	3.06893	1217	3.08529
1083	3.03463	1128	3.05231	1173	3.06930	1218	3.08565
1084	3.03503	1129	3.05269	1174	3.06967	1219	3.08600
1085	3.03543	1130	3.05308	1175	3.07004	1220	3.08636
1086	3.03583	1131	3.05346	1176	3.07041	1221	3.08672
1087	3.03623	1132	3.05385	1177	3.07078	1222	3.08707
1088	3.03663	1133	3.05423	1178	3.07115	1223	3.08743
1089	3.03703	1134	3.05461	1179	3.07151	1234	3.08778
1090	3.03743	1135	3.05500	1180	3.07188	1225	3.08814
1091	3.03782	1136	3.05538	1181	3.07225	1226	3.08849
1092	3.03822	1137	3.05576	1182	3.07262	1227	3.08884
1093	3.03862	1138	3.05614	1183	3.07298	1228	3.08920
1094	3.03902	1139	3.05652	1184	3.07335	1229	3.08955
1095	3.03941	1140	3.05690	1185	3.07372	1230	3.08991
1096	3.03981	1141	3.05729	1186	3.07408	1231	3.09026
1097	3.04021	1142	3.05767	1187	3.07445	1232	3.09061
1098	3.04060	1143	3.05805	1188	3.07482	1233	3.09096
1099	3.04100	1144	3.05843	1189	3.07518	1234	3.09132
1100	3.04139	1145	3.05881	1190	3.07555	1235	3.09167
1101	3.04179	1146	3.05918	1191	3.07591	1236	3.09202
1102	3.04218	1147	3.05956	1192	3.07628	1237	3.09237
1103	3.04258	1148	3.05994	1193	3.07664	1238	3.09272
1104	3.04297	1149	3.06032	1194	3.07700	1239	3.09307
1105	3.04336	1150	3.06070	1195	3.07737	1240	3.09342
1106	3.04376	1151	3.06108	1196	3.07773	1241	3.09377
1107	3.04415	1152	3.06145	1197	3.07809	1242	3.09412
1108	3.04454	1153	3.06183	1198	3.07846	1243	3.09447
1109	3.04493	1154	3.06221	1199	3.07882	1244	3.09482
1110	3.04532	1155	3.06258	1200	3.07918	1245	3.09517
1111	3.04571	1156	3.06296	1201	3.07954	1246	3.09552
1112	3.04610	1157	3.06333	1202	3.07990	1247	3.09587
1113	3.04650	1158	3.06371	1203	4.08027	1248	3.09621
1114	3.04689	1159	3.06408	1204	3.08063	2249	3.09656
1115	3.04727	1160	3.06446	1205	3.08099	1250	3.09691
1116	3.04766	1161	3.06483	1206	3.08135	1251	3.09726
1117	3.04805	1162	3.06521	1207	3.08171	1252	3.09760
1118	3.04844	1163	3.06558	1208	3.08207	1253	3.09795
1119	3.04883	1164	3.06595	1209	3.08243	1254	3.09830
1120	3.04922	1165	3.06633	1210	3.08279	1255	3.09864
1121	3.04961	1166	3.06670	1211	3.08314	1256	3.09899
1122	3.04999	1167	3.06707	1212	3.08350	1257	3.09934
1123	3.05038	1168	3.06744	1213	3.08386	1258	3.09968
1124	3.05077	1169	3.06781	1214	3.08422	1259	3.10003
1125	3.05115	1170	3.06819	1215	3.08458	1260	3.10037

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
1261	3.10072	1306	3.11594	1351	3.13066	1396	3.14489
1262	3.10106	1307	3.11628	1352	3.13098	1397	3.14520
1263	3.10140	1308	3.11661	1353	3.13130	1398	3.14551
1264	3.19175	1309	3.11694	1354	3.13162	1399	3.14582
1265	3.10209	1310	3.11727	1355	3.13194	1400	3.14613
1266	3.10243	1311	3.11760	1356	3.13226	1401	3.14644
1267	3.10278	1312	3.11793	1357	3.13258	1402	3.14675
1268	3.10312	1313	3.11826	1358	3.13290	1403	3.14706
1269	3.10346	1314	3.11860	1359	3.13322	1404	3.14737
1270	3.10380	1315	3.11893	1360	3.13354	1405	3.14768
1271	3.10415	1316	3.11926	1361	3.13386	1406	3.14799
1272	3.10449	1317	3.11959	1362	3.13418	1407	3.14829
1273	3.10483	1318	3.11992	1363	3.13450	1408	3.14860
1274	3.10517	1319	3.12024	1364	3.13481	1409	3.14891
1275	3.10551	1320	3.12057	1365	3.13513	1410	3.14922
1276	3.10585	1321	3.12090	1366	3.13545	1411	3.14953
1277	3.10619	1322	3.12123	1367	3.13577	1412	3.14983
1278	3.10653	1323	3.12156	1368	3.13609	1413	3.15014
1279	3.10687	1324	3.12189	1369	3.13640	1414	3.15045
1280	3.10721	1325	3.12222	1370	3.13672	1415	3.15076
1281	3.10755	1326	3.12254	1371	3.13704	1416	3.15106
1282	3.10789	1327	3.12287	1372	3.13735	1417	3.15137
1283	3.10823	1328	3.12320	1373	3.13767	1418	3.15168
1284	3.10857	1329	3.12353	1374	3.13799	1419	3.15198
1285	3.10890	1330	3.12385	1375	3.13830	1420	3.15229
1286	3.10924	1331	3.12418	1376	3.13862	1421	3.15259
1287	3.10958	1332	3.12450	1377	3.13893	1422	3.15290
1288	3.10992	1333	3.12483	1378	3.13925	1423	3.15320
1289	3.11025	1334	3.12516	1379	3.13956	1424	3.15351
1290	3.11059	1335	3.12548	1380	3.13988	1425	3.15381
1291	3.11093	1336	3.12581	1381	3.14019	1426	3.15412
1292	3.11126	1337	3.12613	1382	3.14051	1427	3.15442
1293	3.11160	1338	3.12646	1383	3.14082	1428	3.15473
1294	3.11193	1339	3.12678	1384	3.14114	1429	3.15503
1295	3.11227	1340	3.12710	1385	3.14145	1430	3.15534
1296	3.11261	1341	3.12743	1386	3.14176	1431	3.15564
1297	3.11294	1342	3.12775	1387	3.14208	1432	3.15594
1298	3.11327	1343	3.12808	1388	3.14239	1433	3.15625
1299	3.11361	1344	3.12840	1389	3.14270	1434	3.15655
1300	3.11394	1345	3.12872	1390	3.14301	1435	3.15685
1301	3.11428	1346	3.12905	1391	3.14333	1436	3.15715
1302	3.11461	1347	3.12937	1392	3.14364	1437	3.15746
1303	3.11494	1348	3.12969	1393	3.14395	1438	3.15776
1304	3.11528	1349	3.13001	1394	3.14426	1439	3.15806
1305	3.11561	1350	3.13033	1395	3.14457	1440	3.15836

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
1441	3.15866	1486	3.17202	1531	3.18498	1576	3.19756
1442	3.15897	1487	3.17231	1532	3.18526	1577	3.19783
1443	3.15927	1488	3.17260	1533	3.18554	1578	3.19811
1444	3.15957	1489	3.17289	1534	3.18583	1579	3.19838
1445	3.15987	1490	3.17319	1535	3.18611	1580	3.19866
1446	3.16017	1491	3.17348	1536	3.18639	1581	3.19893
1447	3.16047	1492	3.17377	1537	3.18667	1582	3.19921
1448	3.16077	1493	3.17406	1538	3.18696	1583	3.19948
1449	3.16107	1494	3.17435	1539	3.18724	1584	3.19976
1450	3.16137	1495	3.17464	1540	3.18752	1585	3.20003
1451	3.16167	1496	3.17493	1541	3.18780	1586	3.20030
1452	3.16197	1497	3.17522	1542	3.18808	1587	3.20058
1453	3.16227	1498	3.17551	1543	3.18837	1588	3.20085
1454	3.16256	1499	3.17580	1544	3.18865	1589	3.20112
1455	3.16286	1500	3.17609	1545	3.18893	1590	3.20140
1456	3.16316	1501	3.17638	1546	3.18921	1591	3.20167
1457	3.16346	1502	3.17667	1547	3.18949	1592	3.20194
1458	3.16376	1503	3.17696	1548	3.18977	1593	3.20222
1459	3.16406	1504	3.17725	1549	3.19005	1594	3.20249
1460	3.16435	1505	3.17754	1550	3.19033	1595	3.20276
1461	3.16465	1506	3.17783	1551	3.19061	1596	3.20303
1462	3.16495	1507	3.17811	1552	3.19089	1597	3. 0330
1463	3.16524	1508	3.17840	1553	3.19117	1598	3.20358
1464	3.16554	1509	3.17869	1554	3.19145	1599	3.20385
1465	3.16584	1510	3.17898	1555	3.19173	1600	3.20412
1466	3.16613	1511	3.17926	1556	3.19201	1601	3.20439
1467	3.16643	1512	3.17955	1557	3.19229	1602	3.20466
1468	3.16673	1513	3.17984	1558	3.19257	1603	3.20493
1469	3.16702	1514	3.18013	1559	3.19285	1604	3.20520
1470	3.16732	1515	3.18041	1560	3.19312	1605	3.20548
1471	3.16761	1516	3.18070	1561	3.19340	1606	3.20575
1472	3.16791	1517	3.18099	1562	3.19368	1607	3.20602
1473	3.16820	1518	3.18127	1563	3.19396	1608	3.20629
1474	3.16850	1519	3.18156	1564	3.19424	1609	3.20656
1475	3.16879	1520	3.18184	1565	3.19451	1610	3.20683
1476	3.16909	1521	3.18213	1566	3.19479	1611	3.20710
1477	3.16938	1522	3.18241	1567	3.19507	1612	3.20737
1478	3.16967	1523	3.18270	1568	3.19535	1613	3.20763
1479	3.16997	1524	3.18299	1569	3.19562	1614	3.20790
1480	3.17026	1525	3.18327	1570	3.19590	1615	3.20817
1481	3.17056	1526	3.18355	1571	3.19618	1616	3.20844
1482	3.17085	1527	3.18384	1572	3.19645	1617	3.20871
1483	3.17114	1528	3.18412	1573	3.19673	1618	3.20898
1484	3.17143	1529	3.18441	1574	3.19700	1619	3.20925
1485	3.17173	1530	3.18469	1575	3.19728	1620	3.20952

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
1621	3.20978	1666	3.22168	1711	3.23325	1756	3.24452
1622	3.21005	1667	3.22194	1712	3.23350	1757	3.24477
1623	3.21032	1668	3.22220	1713	3.23376	1758	3.24502
1624	3.21059	1669	3.22246	1714	3.23401	1759	3.24527
1625	3.21085	1670	3.22272	1715	3.23426	1760	3.24551
1626	3.21112	1671	3.22298	1716	3.23452	1761	3.24576
1627	3.21139	1672	3.22324	1717	3.23477	1762	3.24601
1628	3.21165	1673	3.22350	1718	3.23502	1763	3.24625
1629	3.21192	1674	3.22376	1719	3.23528	1764	3.24650
1630	3.21219	1675	3.22401	1720	3.23553	1765	3.24674
1631	3.21245	1676	3.22427	1721	3.23578	1766	3.24699
1632	3.21272	1677	3.22453	1722	3.23603	1767	3.24724
1633	3.21299	1678	3.22479	1723	3.23629	1768	3.24748
1634	3.21325	1679	3.22505	1724	3.23654	1769	3.24773
1635	3.21352	1680	3.22531	1724	3.23679	1770	3.24797
1636	3.21378	1681	3.22557	1726	3.23704	1771	3.24822
1637	3.21405	1682	3.22583	1727	3.23729	1772	3.24846
1638	3.21431	1683	3.22608	1728	3.23754	1773	3.24871
1639	3.21458	1684	3.22634	1729	3.23780	1774	3.24895
1640	3.21484	1685	3.22660	1730	3.23805	1775	3.24920
1641	3.21511	1686	3.22686	1731	3.23830	1776	3.24944
1642	3.21537	1687	3.22712	1732	3.23855	1777	3.24969
1643	3.21564	1688	3.22737	1733	3.23880	1778	3.24993
1644	3.21590	1689	3.22763	1734	3.23905	1779	3.25018
1645	3.21617	1690	3.22789	1735	3.23930	1780	3.25042
1646	3.21643	1691	3.22814	1736	3.23955	1781	3.25066
1647	3.21669	1692	3.22840	1737	3.23980	1782	3.25091
1648	3.21696	1693	3.22866	1738	3.24005	1783	3.25115
1649	3.21722	1694	3.22891	1739	3.24030	1784	3.25139
1650	3.21748	1695	3.22917	1740	3.24055	1785	3.25164
1651	3.21775	1696	3.22943	1741	3.24080	1786	3.25188
1652	3.21801	1697	3.22968	1742	3.24105	1787	3.25212
1653	3.21827	1698	3.22994	1743	4.24130	1788	3.25237
1654	3.21854	1699	3.23019	1744	3.24155	1789	3.25261
1655	3.21880	1700	3.23045	1745	3.24180	1790	3.25285
1656	3.21906	1701	3.23070	1746	3.24204	1791	3.25310
1657	3.21932	1702	3.23096	1747	3.24229	1792	3.25334
1658	3.21958	1703	3.23121	1748	3.24254	1793	3.25358
1659	3.21985	1704	3.23147	1749	3.24279	1794	3.25382
1660	3.22011	1705	3.23172	1750	3.24304	1795	3.25406
1661	3.22037	1706	3.23198	1751	3.24329	1796	3.25431
1662	3.22063	1707	3.23223	1752	3.24353	1797	3.25455
1663	3.22089	1708	3.23249	1753	3.24378	1798	3.25479
1664	3.22115	1709	3.23274	1754	3.24403	1799	3.25503
1665	3.22141	1710	3.23300	1755	3.24428	1800	3.25527

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
1801	3.25551	1846	3.26623	1891	3.27669	1936	3.28691
1802	3.25575	1847	3.26647	1892	3.27692	1937	3.28713
1803	3.25600	1848	3.26670	1893	3.27715	1938	3.28735
1804	3.25624	1849	3.26694	1894	3.27738	1939	3.28758
1805	3.25648	1850	3.26717	1895	3.27761	1940	3.28780
1806	3.25672	1851	3.26741	1896	3.27784	1941	3.28803
1807	3.25696	1852	3.26764	1897	3.27807	1942	3.28825
1808	3.25720	1853	3.26788	1898	3.27830	1943	3.28847
1809	3.25744	1854	3.26811	1899	3.27853	1944	3.28870
1810	3.25768	1855	3.26834	1900	3.27875	1945	3.28892
1811	3.25792	1856	3.26858	1901	3.27898	1946	3.28914
1812	3.25816	1857	3.26881	1902	3.27921	1947	3.28937
1813	3.25840	1858	3.26905	1903	3.27944	1948	3.28959
1814	3.25864	1859	3.26928	1904	3.27967	1949	3.28981
1815	3.25888	1860	3.26951	1905	3.27990	1950	3.29003
1816	3.25912	1861	3.16975	1906	3.28012	1951	3.29026
1817	3.25935	1862	3.26998	1907	3.28035	1952	3.29048
1818	3.25960	1863	3.27021	1908	3.28058	1953	3.29070
1819	3.25983	1864	3.27045	1909	3.28081	1954	3.29092
1820	3.26007	1865	3.27068	1910	3.28103	1955	3.29115
1821	3.26031	1866	3.27091	1911	3.28126	1956	3.29137
1822	3.26055	1867	3.27114	1912	3.28149	1957	3.29159
1823	3.26079	1868	3.27138	1913	3.28172	1958	3.29181
1824	3.26102	1869	3.27161	1914	3.28194	1959	3.29203
1825	3.26126	1870	3.27184	1915	3.28217	1960	3.29226
1826	3.26150	1871	3.27207	1916	3.28240	1961	3.29248
1827	3.26174	1872	3.27231	1917	3.28262	1962	3.29270
1828	3.26198	1873	3.27254	1918	3.28285	1963	3.29292
1829	3.26221	1874	3.27277	1919	3.28308	1964	3.29314
1830	3.26245	1875	3.27300	1920	3.28330	1965	3.29336
1831	3.26269	1876	3.27323	1921	3.28353	1966	3.29358
1832	3.26293	1877	3.27346	1922	3.28375	1967	3.29380
1833	3.26316	1878	3.27370	1923	3.28398	1968	3.29403
1834	3.26340	1879	3.27393	1924	3.28421	1969	3.29425
1835	3.26364	1880	3.27416	1925	3.28443	1970	3.29447
1836	3.26387	1881	3.27439	1926	3.28466	1971	3.29469
1837	3.26411	1882	3.27462	1927	3.28488	1972	3.29491
1838	3.26435	1883	3.27485	1928	3.28511	1973	3.29513
1839	3.26458	1884	3.27508	1929	3.28533	1974	3.29535
1840	3.26482	1885	3.27531	1930	3.28556	1975	3.29557
1841	3.26505	1886	3.27554	1931	3.28578	1976	3.29579
1842	3.26529	1887	3.27577	1932	3.28601	1977	3.29601
1843	3.26553	1888	3.27600	1933	3.28623	1978	3.29623
1844	3.26576	1889	3.27623	1934	3.28646	1979	3.29645
1845	3.26600	1890	3.27646	1935	3.28668	1980	3.29667

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
1981	3.29688	2026	3.30664	2071	3.31618	2116	3.32552
1982	3.29710	2027	3.30685	2072	3.31639	2117	3.32572
1983	3.29732	2028	3.30707	2073	3.31660	2118	3.32593
1984	3.29754	2029	3.30728	2074	3.31681	2119	3.32613
1985	3.29776	2030	3.30750	2075	3.31702	2120	3.32634
	3.29798	2031	3.30771	2076	3.31723	2121	3.32654
	3.29820	2032	3.30792	2077	3.31744	2122	3.32675
	3.29842	2033	3.30814	2078	3.31765	2123	3.32695
	3.29863	2034	3.30835	2079	3.31785	2124	3.32715
	3.29885	2035	3.30856	2080	3.31806	2125	3.32736
	3.29907	2036	3.30878	2081	3.31827	2126	3
	3.29929	2037	3.30899	2082	3.31848	2127	3
	3.29951	2038	3.30920	2083	3.31869	2128	3
	3.29973	2039	3.30942	2084	3.31890	2129	3
	3.29994	2040	3.30963	2085	3.31911	2130	3
	3.30016	2041	3.30984	2086	3.31931	2131	
	3.30038	2042	3.31006	2087	3.31952	2132	3
	3.30060	2043	3.31027	2088	3.31973	2133	3
	3.30081	2044	3.31048	2089	3.31994	2134	3
	3.30103	2045	3.31069	2090	3.32015	2135	3
	3.30125	2046	3.31091	2091	3.32035	2136	3.32960
	3.30146	2047	3.31112	2092	3.32056	2137	3.32980
	3.30168	2048	3.31133	2093	3.32077	2138	3.33001
	3.30190	2049	3.31154	2094	3.32098	2139	3.33021
	3.30211	2050	3.31175	2095	3.32118	2140	3.33041
	3.30233	2051	3.31197	2096	3.32139	2141	3.33062
	3.30255	2052	3.31218	2097	3.32160	2142	3.33082
	3.30276	2053	3.31239	2098	3.32181	2143	3.33102
	3.30298	2054	3.31260	2099	3.32201	2144	3.33122
	3.30320	2055	3.31281	2100	3.32222	2145	3.33143
	3.30341	2056	3.31302	2101	3.32243	2146	3.33163
	3.30363	2057	3.31323	2102	3.32263	2147	3.33183
	3.30384	2058	3.31345	2103	3.32284	2148	3.33203
	3.30406	2059	3.31366	2104	3.32305	2149	3.33224
	3.30428	2060	3.31387	2105	3.32325	2150	3.33244
	3.30449	2061	3.31408	2106	3.32346	2151	3.33264
	3.30471	2062	3.31429	2107	3.32366	2152	3.33284
	3.30492	2063	3.31450	2108	3.32387	2153	3.33304
	3.30514	2064	3.31471	2109	3.32408	2154	3.33325
	3.30535	2065	3.31492	2110	3.32428	2155	3.
	3.30557	2066	3.31513	2111	3.32449	2156	3.
	3.30578	2067	3.31534	2112	3.32469	2157	3.
	3.30600	2068	3.31555	2113	3.32490	2158	3.
	3.30621	2069	3.31576	2114	3.32511	2159	3.
	3.30643	2070	3.31597	2115	3.32531	2160	3.

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
2161	3.33465	2206	3.34361	2251	3.35238	2296	3.36097
2162	3.33486	2207	3.34380	2252	3.35257	2297	3.36116
2163	3.33506	2208	3.34400	2253	3.35276	2298	3.36135
2164	3.33526	2209	3.34420	2254	3.35295	2299	3.36154
2165	3.33546	2210	3.34439	2255	3.35315	2300	3.36173
2166	3.33566	2211	3.34459	2256	3.35334	2301	3.36192
2167	3.33586	2212	3.34479	2257	3.35353	2302	3.36211
2168	3.33606	2213	3.34498	2258	3.35372	2303	3.36229
2169	3.33626	2214	3.34518	2259	3.35392	2304	3.36248
2170	3.33646	2215	3.34537	2260	3.35411	2305	3.36267
2171	3.33666	2216	3.34557	2261	3.35430	2306	3.36286
2172	3.33686	2217	3.34577	2262	3.35449	2307	3.36305
2173	3.33706	2218	3.34596	2263	3.35468	2308	3.36324
2174	3.33726	2219	3.34616	2264	3.35488	2309	3.36342
2175	3.33746	2220	3.34635	2265	3.35507	2310	3.36361
2176	3.33766	2221	3.34655	2266	3.35526	2311	3.36380
2177	3.33786	2222	3.34674	2267	3.35545	2312	3.36399
2178	3.33806	2223	3.34694	2268	3.35564	2313	3.36418
2179	3.33826	2224	3.34713	2269	3.35583	2314	3.36436
2180	3.33846	2225	3.34733	2270	3.35603	2315	3.36455
2181	3.33866	2226	3.34753	2271	3.35622	2316	3.36474
2182	3.33885	2227	3.34772	2272	3.35641	2317	3.36493
2183	3.33905	2228	3.34792	2273	3.35660	2318	3.36511
2184	3.33925	2229	3.34811	2274	3.35679	2319	3.36530
2185	3.33945	2230	3.34830	2275	3.35698	2320	3.36549
2186	3.33965	2231	3.34850	2276	3.35717	2321	3.36568
2187	3.33985	2232	3.34869	2277	3.35736	2322	3.36586
2188	3.34005	2233	3.34889	2278	3.35755	2323	3.36605
2189	3.34025	2234	3.34908	2279	3.35774	2324	3.36624
2190	3.34044	2235	3.34928	2280	3.35793	2325	3.36642
2191	3.34064	2236	3.34947	2281	3.35813	2326	3.36661
2192	3.34084	2237	3.34967	2282	3.35832	2327	3.36680
2193	3.34104	2238	3.34986	2283	3.35851	2328	3.36698
2194	3.34124	2239	3.35005	2284	3.35870	2329	3.36717
2195	3.34143	2240	3.35025	2285	3.35889	2330	3.36736
2196	3.34163	2241	3.35044	2286	3.35908	2331	3.36754
2197	3.34183	2242	3.35064	2287	3.35927	2332	3.36773
2198	3.34203	2243	3.35083	2288	3.35946	2333	3.36791
2199	3.34223	2244	3.35102	2289	3.35965	2334	3.36810
2200	3.34242	2245	3.35122	2290	3.35984	2335	3.37829
2201	3.34262	2246	3.35141	2291	3.36003	2336	3.36847
2202	3.34282	2247	3.35160	2292	3.36021	2337	3.36866
2203	3.34301	2248	3.35180	2293	3.36040	2338	3.36884
2204	3.34321	2249	3.35199	2294	3.36059	2339	3.36903
2205	3.34341	2250	3.35218	2295	3.36078	2340	3.36922

N.	Logar.	N.	Logar.	N	Logar.	N.	Logar.
2341	3.36940	2386	3.37767	2431	3.38579	2476	3.39375
2342	3.36959	2387	3.37785	2432	3.38596	2477	3.39393
2343	3.36977	2388	3.37803	2433	3.38614	2478	3.39410
2344	3.36996	2389	3.37822	2434	3.38632	2479	3.39428
2345	3.37014	2399	3.37840	2435	3.38650	2480	3.39445
2346	3.37033	2391	3.37858	2436	3.38668	2481	3.39463
2347	3.37051	2392	3.37876	2437	3.38686	2482	3.39480
2348	3.37070	2393	3.37894	2438	3.38703	2483	3.39498
2349	3.37088	2394	3.37912	2439	3.38721	2484	3.39515
2350	3.37107	2395	3.37931	2440	3.38739	2485	3.39533
2351	3.37125	2396	3.37949	2441	3.38757	2486	3.39550
2352	3.37144	2397	3.37967	2442	3.38775	2487	3.39568
2353	3.37162	2398	3.37985	2443	3.38792	2488	3.39585
2354	3.37181	8399	3.38003	2444	3.38810	2489	3.39602
2355	3.37199	2400	3.38021	2445	3.38828	2490	3.39620
2356	3.37218	2401	3.38039	2446	3.38846	2491	3.39637
2357	3.37236	2402	3.38057	2447	3.38863	2492	3.39655
2358	3.37254	2403	3.38075	2448	3.38881	2493	3.39672
2359	3.37273	2404	3.38093	2449	3.38899	2494	3.39690
2360	3.37291	2405	3.38112	2450	3.38917	2495	3.39707
2361	3.37310	2406	3.38130	2451	3.38934	2496	3.39724
2362	3.37328	2407	3.38146	2452	3.38952	2497	3.39741
2363	3.37346	2408	3.38166	2453	3.38970	2498	3.39759
2364	3.37365	2409	3.38184	2454	3.38987	2499	3.39777
2365	3.37383	2410	3.38202	2455	3.39005	2500	3.39794
2366	3.37401	2411	3.38220	2456	3.39022	2501	3.39811
2367	3.37420	2412	3.38238	2457	3.39041	2502	3.39829
2368	3.37438	2413	3.38256	2458	3.39058	2503	3.39846
2369	3.37457	2414	3.38274	2459	3.39076	2504	3.39863
2370	3.37475	2415	3.38292	2460	3.39094	2505	3.39881
2371	3.37493	2416	3.38310	2461	3.39111	2506	3.39898
2372	3.37511	2417	3.38328	2462	3.39129	2507	3.39915
2373	3.37530	2418	3.38346	2463	3.39146	2508	3.39933
2374	3.37548	2419	3.38364	2464	3.39164	2509	3.39950
2375	3.37566	2420	3.38382	2465	3.39182	2510	3.39967
2376	3.37585	2421	3.38399	2466	3.39199	2511	3.39985
2377	3.37603	2422	3.38417	2467	3.39217	2512	3.40002
2378	3.37621	2423	3.38435	2468	3.39236	2513	3.40019
2379	3.37639	2424	3.38453	2469	3.39252	2514	3.40037
2380	3.37658	2425	3.38471	2470	3.39270	2515	3.40054
2381	3.37676	2426	3.38489	2471	3.39287	2516	3.40071
2382	3.37694	2427	3.38507	2472	3.39305	2517	3.40088
2383	3.37712	2428	3.38525	2473	3.39322	2518	3.40106
2384	3.37731	2429	3.38543	2474	3.39340	2519	3.40123
2385	3.37749	2430	3.38561	2475	3.39358	2520	3.40140

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
2521	3.40157	2566	3.40926	2611	3.41681	2656	3.42423
2522	3.40175	2567	3.40943	2612	3.41697	2657	3.42439
2523	3.40192	2568	3.40960	2613	3.41714	2658	3.42456
2524	3.40209	2569	3.40976	2614	3.41731	2659	3.42472
2525	3.40226	2570	3.40993	2615	3.41747	2660	3.42488
2526	3.40243	2571	3.41010	2616	3.41764	2661	3.42504
2527	3.40261	2572	3.41027	2617	3.41780	2662	3.42521
2528	3.40278	2573	3.41044	2618	3.41797	2663	3.42537
2529	3.40295	2574	3.41061	2619	3.41814	2664	3.42553
2530	3.40312	2575	3.41078	2620	3.41830	2665	3.42570
2531	3.40329	2576	3.41095	2621	3.41847	2666	3.42586
2532	3.40346	2577	3.41111	2622	3.41863	2667	3.42602
2533	3.40364	2578	3.41128	2623	3.41880	2668	3.42619
2534	3.40381	2579	3.41145	2624	3.41896	2669	3.42635
2535	3.40398	2580	3.41162	2625	3.41913	2670	3.42651
2536	3.40415	2581	3.41179	2626	3.41929	2671	3.42667
2537	3.40432	2582	3.41196	2627	3.41946	2672	3.42684
2538	3.40449	2583	3.41212	2628	3.41963	2673	3.42700
2539	3.40466	2584	3.41229	2629	3.41979	2674	3.42716
2540	3.40483	2585	3.41246	2630	3.41996	2675	3.42732
2541	3.40500	2586	3.41263	2631	3.42012	2676	3.42749
2542	3.40518	2587	3.41280	2632	3.42029	2677	3.42765
2543	3.40535	2588	3.41296	2633	3.42045	2678	3.42781
2544	3.40552	2589	3.41313	2634	3.42062	2679	3.42797
2545	3.40569	2590	3.41330	2635	3.42078	2680	3.42813
2546	3.40586	2591	3.41347	2636	3.42095	2681	3.42830
2547	3.40603	2592	3.41364	2637	3.42111	2682	3.42846
2548	3.40620	2593	3.41380	2638	3.42127	2683	3.42862
2549	3.40637	2594	3.41397	2639	3.42144	2684	3.42878
2550	3.40654	2595	3.41414	2640	3.42160	2685	3.42894
2551	3.40671	2596	341430	2641	3.42177	2686	3.42911
2552	3.40688	2597	3.41447	2642	3.42193	2687	3.42927
2553	3.40705	2598	3.41464	2643	3.42210	2688	3.42943
2554	3.40722	2599	3.41481	2644	3.42226	2689	3.42959
2555	3.40739	2600	3.41497	2645	3.42243	3690	3.42975
2556	3.40756	2601	3.41514	2646	3.42259	2091	3.42991
2557	3.40773	2602	3.41531	2647	3.42275	2692	3.43008
2558	3.40790	2603	3.41547	2648	3.42292	2693	3.43024
2559	3.40807	2604	3.41564	2649	3.42308	2694	3.43040
2560	3.40824	2605	3.41581	2650	3.42325	2695	3.43056
2561	3.40841	2606	3.41597	2651	3.42341	2696	3.43072
2562	3.40858	2607	3.41614	2652	3.42357	2697	3.43088
2563	3.40875	2608	3.41631	2653	3.42374	2698	3.43104
2564	3.40892	2609	3.41647	2654	3.42390	2699	3.43120
2565	3.40909	2610	3.41664	2655	3.42406	2700	3.43136

N.	Logar.	N	Logar.	N.	Logar.	N.	Logar.
2701	3.43152	2746	3.43870	2791	3.44576	2836	3.45271
2702	3.43169	2747	3.43886	2792	3.44592	2837	3.45286
2703	3.43185	2748	3.43902	2793	3.44607	2838	3.45301
2704	3.43201	2749	3.43917	2794	3.44623	2839	3.45317
2705	3.43217	2750	3.43933	2795	3.44638	2840	3.45332
2706	3.43233	2751	3.43949	2796	3.44654	2841	3.45347
2707	3.43249	2752	3.43965	2797	3.44669	2842	3.45362
2708	3.43265	2753	3.43981	2798	3.44685	2843	3.45378
2709	3.43281	2754	3.43996	2799	3.44700	2844	3.45393
2710	3.43297	2755	3.44012	2800	3.44716	2845	3.45408
2711	3.43313	2756	3.44028	2801	3.44731	2846	3.45423
2712	3.43329	2757	3.44044	2802	3.44747	2847	3.45439
2713	3.43345	2758	3.44059	2803	3.44762	2848	3.45454
2714	3.43361	2759	3.44075	2804	3.44778	2849	3.45469
2715	3.43377	2760	3.44091	2805	3.44793	2850	3.45484
2716	3.43393	2761	3.44107	2806	3.44809	2851	3.45500
2717	3.43409	2762	3.44122	2807	3.44824	2852	3.45515
2718	3.43425	2763	3.44138	2808	3.44840	2853	3.45530
2719	3.43441	2764	3.44154	2809	3.44855	2854	3.45545
2720	3.43457	2765	3.44170	2810	3.44871	2855	3.45561
2721	3.43473	2766	3.44185	2811	3.44886	2856	3.45576
2722	3.43489	2767	3.44201	2812	3.44902	2857	3.45591
2723	3.43505	2768	3.44217	2813	3.44917	2858	3.45606
2724	3.43521	2769	3.44232	2814	3.44932	2859	3.45621
2725	3.43537	2770	3.44248	2815	3.44948	2860	3.45637
2726	3.43553	2771	3.44264	2816	3.44963	2861	3.45652
2727	3.43569	2772	3.44279	2817	3.44979	2862	3.45667
2728	3.43584	2773	3.44295	2818	3.44994	2863	3.45682
2729	3.43600	2774	3.44311	2819	3.45010	2864	3.45697
2730	3.43616	2775	3.44326	2820	3.45025	2865	3.45712
2731	3.43632	2776	3.44342	2821	3.45040	2866	3.45728
2732	3.43648	2777	3.44358	2822	3.45056	2867	3.45743
2733	3.43664	2778	3.44373	2823	3.45071	2868	3.45758
2734	3.43680	2779	3.44389	2824	3.45086	2869	3.45773
2735	3.43696	2780	3.44404	2825	3.45102	2870	3.45788
2736	3.43712	2781	3.44420	2826	3.45117	2871	3.45803
2737	3.43727	2782	3.44436	2827	3.45133	2872	3.45818
2738	3.43743	2783	3.44451	2828	3.45148	2873	3.45834
2739	3.43759	2784	3.44467	2829	3.45163	2874	3.45849
2740	3.43775	2785	3.44483	2830	3.45179	2875	3.45864
2741	3.43791	2786	3.44498	2831	3.45194	2876	3.45879
2742	3.43807	2787	3.44514	2832	3.45209	2877	3.45894
2743	3.43823	2788	3.44529	2933	3.45225	2878	3.45909
2744	3.43838	2789	3.44545	2834	3.45240	2879	3.45924
2145	3.43854	2790	3.44560	2835	3.45255	2880	3.45939

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
2881	3.45954	2926	3.46627	2971	3.47290	3016	3.47943
2882	3.45969	2927	3.46642	2972	3.47305	3017	3.47958
2883	3.45984	2928	3.46657	2973	3.47319	3018	3.47972
2884	3.46000	2929	3.46672	2974	3.47334	3019	3.47986
2885	3.46015	2930	3.46687	2975	3.47349	3020	3.48001
2886	3.46030	2931	3.46702	2976	3.47363	3021	3.48015
2887	3.46045	2932	3.46716	2977	3.47378	3022	3.48029
2888	3.46060	2933	3.46731	2978	3.47392	3023	3.48044
2889	3.46075	2934	3.46746	2979	3.47407	3024	3.48058
2890	3.46090	2935	3.46761	2980	3.47422	3025	3.48073
2891	3.46105	2936	3.46776	2981	3.47436	3026	3.48087
2892	3.46120	2937	3.46790	2982	3.47451	3027	3.48101
2893	3.46135	2938	3.46805	2983	3.47465	3028	3.48116
2894	3.46150	2939	3.46820	2984	3.47480	3029	3.48130
2895	3.46165	2940	3.46835	2985	3.47494	3030	3.48144
2896	3.46180	2941	3.46850	2986	3.47509	3031	3.48159
2897	3.46195	2942	3.46864	2987	3.47524	3032	3.48173
2898	3.46210	2943	3.46879	2988	3.47538	3033	3.48187
2899	3.46225	2944	3.46894	2989	3.47553	3034	3.48202
2900	3.46240	2945	3.46909	2990	3.47567	3035	3.48216
2901	3.46255	2946	3.46923	2991	3.47582	3036	3.48230
2902	3.46270	2947	3.46938	2992	3.47596	3037	3.48244
2903	3.46285	2948	3.46953	2993	3.47611	3038	3.48259
2904	3.46300	3949	3.46967	2994	3.47625	3039	3.48273
2905	3.46315	2950	3.46982	2995	3.47640	3040	3.48287
2906	3.4 330	2951	3.46997	2996	3.47654	3041	3.48302
2907	3.46345	2952	3.47012	2997	3.47669	3042	3.48316
2908	3.46360	2953	3.47026	2998	3.37683	3043	3.48330
2909	3.46374	2954	3.47041	2999	3.47698	3044	3.48344
2910	3.46389	2955	3.47056	3000	3.47712	3045	3.48359
2911	3.46404	2956	3.47070	3001	3.47727	3046	3.48373
2912	3.46419	2957	3.47085	3002	3.47741	3047	3.48387
2913	3.46434	2958	3.47100	3003	3.47756	3048	3.48402
2914	3.46449	2959	3.47115	3004	3.47770	3049	3.48416
2915	3.46464	2960	3.47129	3005	3.47784	3050	3.48430
2916	3.46479	2961	3.47144	3006	3.47799	3051	3.48444
2917	3.46494	2962	3.47159	3007	3.47813	3052	3.48458
2918	3.46509	2963	3.47173	3008	3.47828	3053	3.48473
2919	3.46523	2964	3.47188	3009	3.47842	3054	3.48487
2920	3.46538	2965	3.47202	3010	3.47857	3055	3.48501
2921	3.46553	2966	3.47217	3011	3.47871	3056	3.48515
2922	3.46568	2967	3.47232	3012	3.47886	3057	3.48530
2923	3.46583	2968	3.47246	3013	3.47900	3058	3.48544
2924	3.46598	2969	3.47261	3014	3.47914	3059	3.48558
2925	3.46613	2970	3.47276	3015	3.47929	3060	3.48572

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
3061	3.48586	3106	3.49220	3151	3.49845	3196	3.50461
3062	3.48601	3107	3.49234	3152	3.49859	3197	3.50474
3063	3.48615	3108	3.49248	3153	3.49872	3198	3.50488
3064	3.48629	3109	3.49262	3154	3.49886	3199	3.50501
3065	3.48643	3110	3.49276	3155	3.49900	3200	3.50515
3066	3.48657	3111	3.49290	3156	3.49914	3201	3.50529
3067	3.48671	3112	3.49304	3157	3.49927	3202	3.50542
3068	3.48686	3113	3.49318	3158	3.49941	3203	3.50556
3069	3.48700	3114	3.49332	3159	3.49955	3204	3.50569
3070	3.48714	3115	3.49346	3160	3.49969	3205	3.50583
3071	3.48728	3116	3.49360	3161	3.49982	3206	3.50596
3072	3.48742	3117	3.49374	3162	3.49996	3207	3.50610
3073	3.48756	3118	3.49388	3163	3.50010	3208	3.50623
3074	3.48770	3119	3.49402	3164	3.50024	3209	3.50637
3075	3.48785	3120	3.49415	3165	3.50037	3210	3.50651
3076	3.48799	3121	3.49429	3166	3.50051	3211	3.50664
3077	3.48813	3122	3.49443	3167	3.50065	3212	3.50678
3078	3.48827	3123	3.49457	3168	3.50079	3213	3.50691
3079	3.48841	3124	3.49471	3169	3.50092	3214	3.50705
3080	3.48855	3125	3.49485	3170	3.50106	3215	3.50718
3081	3.48869	3126	3.49499	3171	3.50120	3216	3.50732
3082	3.48883	3127	3.49513	3172	3.50133	3217	3.50745
3083	3.48897	3128	3.49527	3173	3.50147	3218	3.50759
3084	3.48911	3129	3.49541	3174	3.50161	3219	3.50772
3085	3.48926	3130	3.49554	3175	3.50174	3220	3.50786
3086	3.48940	3131	3.49568	3176	3.50188	3221	3.50799
3087	3.48954	3132	3.49582	3177	3.50202	3222	3.50813
3088	3.48968	3133	3.49596	3178	3.50215	3223	3.50826
3089	3.48982	3134	3.49610	3179	3.50229	3224	3.50840
3090	3.48996	3135	3.49624	3180	3.50243	3225	3.50853
3091	3.49010	3136	3.49638	3181	3.50256	3226	3.50866
3092	3.49024	3137	3.49651	3182	3.50270	3227	3.50880
3093	3.49038	3138	3.49665	3183	3.50284	3228	3.50893
3094	3.49052	3139	3.49679	3184	3.50297	3229	3.50907
3095	3.49066	3140	3.49693	3185	3.50311	3230	3.50920
3096	3.49080	3141	3.49707	3186	3.50325	3231	3.50934
3097	3.49094	3142	3.49721	3187	3.50338	3232	3.50947
3098	3.49108	3143	3.49734	3188	3.50352	3233	3.50961
3099	3.49122	3144	3.49748	3189	3.50365	3234	3.50974
3100	3.49136	3145	3.49762	3190	3.50379	3235	3.50987
3101	3.49150	3146	3.49776	3191	3.50393	3236	3.51001
3102	3.49164	3147	3.49790	3192	3.50406	3237	3.51014
3103	3.49178	3148	3.49803	3193	3.50420	3238	3.51028
3104	3.49192	3149	3.49817	3194	3.50433	3239	3.51041
3105	3.49206	3150	3.49831	3195	3.50447	3240	3.51055

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
3241	3.51068	3286	3.51667	3331	3.52257	3376	3.52840
3242	3.51081	3287	3.51680	3332	3.52271	3377	3.52853
3243	3.51095	3288	3.51693	3333	3.52284	3378	3.52866
3244	3.51108	3289	3.51706	3334	3.52297	3379	3.52879
3245	3.51121	3290	3.51720	3335	3.52310	3380	3.52892
3246	3.51135	3291	3.51733	3336	3.52323	3381	3.52905
3247	3.51148	3292	3.51746	3337	3.52336	3382	3.52917
3248	3.51162	3293	3.51759	3338	3.52349	3383	3.52930
3249	3.51175	3294	3.51772	3339	3.52362	3384	3.52943
3250	3 51188	3295	3.51786	3340	3.52375	3385	3.52956
3251	3.51202	3296	3.51799	3341	3.52388	3386	3.52969
3252	3.51215	3297	3.51812	3342	3.52401	3387	3.52982
3253	3.51228	3298	3.51825	3343	3.52414	3388	3.52994
3254	3.51242	3299	3.51838	3344	3.52427	3389	3.53007
3255	3.51255	3300	3.51851	3345	3.52440	3390	3.53020
3256	3.51268	3301	3.51865	3346	3.52453	3391	3.53033
3257	3.51282	3302	3.51878	3347	3.52466	3392	3.53046
3258	3.51295	3303	3.51891	3348	3.52479	3393	3.53058
3259	3.51308	3304	3.51904	3349	3.52492	3394	3.53071
3260	3.51322	3305	3.51917	3350	3.52504	3395	3.53084
3261	3.51335	3306	3.51930	3351	3.52517	3396	3.53097
3262	3.51348	3307	3.51943	3352	3.52530	3397	3.53110
3263	3.51362	3308	3.51957	3353	3.52543	3398	3.53122
3264	3.51375	3309	3.51970	3354	3.52556	3399	3.53135
3265	3.51388	3310	3.51983	3355	3.52569	3400	3.53148
3266	3.51402	3311	3.51996	3356	3.52582	3401	3.53161
3267	3.51415	3312	3.52009	3357	3.52595	3402	3.53173
3268	3.51428	3313	3.52022	3358	3.52608	3403	3.53186
3269	3.51441	3314	3.52035	3359	3.52621	3404	3.53199
3270	3.51455	3315	3.52048	3360	3.52634	3405	3.53212
3271	3.51468	3316	3.52061	3361	3.52647	3406	3.53224
3272	3.51481	3317	3.52075	3362	3.52660	3407	3.53237
3273	3.51495	3318	3.52088	3363	3.52673	3408	3.53250
3274	3.51508	3319	3.52101	3364	3.52686	3409	3.53263
3275	3.51521	3320	3.52114	3365	3.52699	3410	3.53275
3276	3.51534	3321	3.52127	3366	3.52711	3411	3.53288
3277	3.51548	3322	3.52140	3367	3.52724	3412	3.53301
3278	3.51561	3323	3.52153	3368	3.52737	3413	3.53314
3279	3.51574	3324	3.52166	3369	3.52750	3414	3.53326
3280	3.51587	3325	3.52179	3370	3.52763	3415	3.53339
3281	3.51601	3326	3.52192	3371	3.52776	3416	3.53352
3282	3.51614	3327	3.52205	3372	3.52789	3417	3.53365
3283	3.51627	3328	3.52218	3373	3.52802	3418	3.53377
3284	3.51640	3329	3.52231	3374	3.52815	3419	3.53390
3285	3.51654	3330	3.52244	3375	3.52827	3420	3.53403

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
3421	3.53415	3466	3.53983	3511	3.54543	3556	3.55096
3422	3.53428	3467	3.53995	3512	3.54555	3557	3.55108
3423	3.53441	3468	3.54008	3513	3.54568	3558	3.55121
3424	3.53453	3469	3.54020	3514	3.54580	3559	3.55133
3425	3.53466	3470	3.54033	3515	3.54593	3560	3.55145
3426	3.53479	3471	3.54045	3516	3.54605	3561	3.55157
3427	3.53491	3472	3.54058	3517	3.54617	3562	3.55169
3428	3.53504	3473	3.54070	3518	3.54630	3563	3.55182
3429	3.53517	3474	3.54083	3519	3.54642	3564	3.55194
3430	3.53529	3475	3.54095	3520	3.54654	3565	3.55206
3431	3.53542	3476	3.54108	3521	3.54667	3566	3.55218
3432	3.53555	3477	3.54120	3522	3.54679	3567	3.55230
3433	3.53567	3478	3.54133	3523	3.54691	3568	3.55242
3434	3.53580	3479	3.54145	3524	3.54704	3569	3.55255
3435	3.53593	3480	3.54158	3525	3.54716	3570	3.55267
3436	3.53605	3481	3.54170	3526	3.54728	3571	3.55279
3437	3.53618	3482	3.54183	3527	3.34741	3572	3.55291
3438	3.53631	3483	3.54195	3528	3.54753	3573	3.55303
3439	3.53643	3484	3.54208	3529	3.54765	3574	3.55315
3440	3.53656	3485	3.54220	3530	3.54777	3575	3.55328
3441	3.53668	3486	3.54233	3531	3.54790	3576	3.55340
3442	3.53681	3487	3.54245	3532	3.54802	3577	3.55352
3443	3.53694	3488	3.54258	3533	3.54814	3578	3.55364
3444	3.43706	3489	3.54270	3534	3.54827	3579	3.55376
3445	3.53719	3490	3.54283	3535	3.54839	3580	3.55388
3446	3.53732	3491	3.54295	3536	3.54851	3581	3.55400
3447	3.53744	3492	3.54307	3537	3.54864	3582	3.55413
3448	3.53757	3493	3.54320	3538	3.54876	3583	3.55425
3449	3.53769	3494	3.54332	3539	3.54888	3584	3.55437
3450	3.53782	3495	3.54345	3540	3.54900	3585	3.55449
3451	3.53795	3496	3.54357	3541	3.54913	3586	3.55461
3452	3.53807	3497	3.54370	3542	3.54925	3587	3.55473
3453	3.53820	3498	3.54382	3543	3.54937	3588	3.55485
3454	3.53832	3499	3.54394	3544	3.54949	3589	3.55497
3455	3.53845	3500	3.54407	3545	3.54962	3590	3.55509
3456	3.53857	3501	3.54419	3546	3.54974	3591	3.55522
3457	3.53870	3502	3.54432	3547	3.54986	3592	3.55534
3458	3.53883	3503	3.54444	3548	3.54998	3593	3.55546
3459	3.53895	3504	3.54456	3549	3.55011	3594	3.55558
3460	3.53908	3505	3.54469	3550	3.55023	3595	3.55570
3461	3.53920	3506	3.54481	3551	3.55035	3596	3.55582
3462	3.53933	3507	3.54494	3552	3.55047	3597	3.55594
3463	3.53945	3508	3.54506	3553	3.55060	3598	3.55606
3464	3.53958	3509	3.54518	3554	3.55072	3599	3.55618
3465	3.53970	3510	3.54531	3555	3.55084	3600	3.55630

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
3601	3.55642	3646	3.56182	3691	3.56714	3736	3.57241
3602	3.55654	3647	3.56194	3692	3.56726	3737	3.57252
3603	3.55666	3648	3.56205	3693	3.56738	3738	3.57264
3604	3.55678	3649	3.56217	3694	3.56750	3739	3.57276
3605	3.55691	3650	3.56229	3695	3.56761	3740	3.57287
3606	3.55703	3651	3.56241	3696	3.56773	3741	3.57299
3607	3.55715	3652	3.56253	3697	3.56785	3742	3.57310
3608	3.55727	3653	3.56265	3698	3.56797	3743	3.57322
3609	3.55739	3654	3.56277	3699	3.56808	3744	3.57334
3610	3.55751	3655	3.56289	3700	3.56820	3745	3.57345
3611	3.55763	3656	3.56301	3701	3.56832	3746	3.57357
3612	3.55775	3657	3.56313	3702	3.56844	3747	3.57368
3613	3.55787	3658	3.56324	3703	3.56855	3748	3.57380
3614	3.55799	3659	3.56336	3704	3.56867	3749	3.57392
3615	3.55811	3660	3.56348	3705	3.56879	3750	3.57403
3616	3.55823	3661	3.56360	3706	3.56891	3751	3.57415
3617	3.55835	3662	3.56372	3707	3.56902	3752	3.57426
3618	3.55847	3663	3.56384	3708	3.56914	3753	3.57438
3619	3.55859	3664	3.56396	3709	3.56926	3754	3.57449
3620	3.55874	3665	3.56407	3710	3.56937	3755	3.57461
3621	3.55882	3666	3.56419	3711	3.56949	3756	3.57473
3622	3.55895	3667	3.56431	3712	3.56961	3757	3.57484
3623	3.55907	3668	3.56443	3713	3.56972	3758	3.57496
3624	3.55919	3669	3.56455	3714	3.56984	3759	3.57507
3625	3.55931	3670	3.56467	3715	3.56996	3760	3.57519
3626	3.55943	3671	3.56478	3716	3.57008	3761	3.57530
3627	3.55955	3672	3.56490	3717	3.57019	3762	3.57542
3628	3.55967	3673	3.56502	3718	3.57031	3763	3.57553
3629	3.55979	3674	3.56514	3719	3.57043	3764	3.57565
3630	3.55991	3675	3.56526	3720	3.57054	3765	3.57577
3631	3.50003	3676	3.56538	3721	3.57066	3766	3.57588
3632	3.56015	3677	3.56549	3722	3.57078	3767	3.57600
3633	3.56026	3678	3.56561	3723	3.57089	3768	3.57611
3634	3.56038	3679	3.56573	3724	3.57101	3769	3.57623
3635	3.56050	3680	3.56585	3725	3.57113	3770	3.57634
3636	3.56062	3681	3.56597	3726	3.57124	3771	3.57646
3637	3.56074	3682	3.56608	3727	3.57136	3772	3.57657
3638	3.56086	3683	3.56620	3728	3.57148	3773	3.57669
3639	3.56098	3684	3.56632	3729	3.57159	3774	3.57680
3640	3.56110	3685	3.56644	3730	3.57171	3775	3.57692
3641	3.56122	3686	3.56656	3731	3.57183	3776	3.57703
3642	3.56134	3687	3.56667	3732	3.57194	3777	3.57715
3643	3.56146	3688	3.56679	3733	3.57206	3778	3.57726
3644	3.56158	3689	3.56691	3734	3.57217	3779	3.57738
3645	3.56170	3690	3.56703	3735	3.57229	3780	3.57749

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
3781	3.57761			3871	3.58782	3916	3.59284
3782	3.57772			3872	3.58796	3917	3.59295
3783	3.57784			3873	3.58805	3918	3.59306
3784	3.57795			3874	3.58816	3919	3.59318
3785	3.57807			3875	3.58827	3920	3.59329
3786	3.57818			3876	3.58838	3921	3.59340
3787	3.57830			3877	3.58850	3922	3.59351
3788	3.57841			3878	3.58861	3923	3.59362
3789	3.57852			3879	3.58872	3924	3.59373
3790	3.57864			3880	3.58883	3925	3.59384
3791	3.57875			3881	3.58894	3926	3.59395
3792	3.57887			3882	3.58906	3927	3.59406
3793	3.57898			3883	3.58917	3928	3.59417
3794	3.57910			3884	3.58928	3929	3.59428
3795	3.57921			3885	3.58939	3930	3.59439
3796	3.57933			3886	3.58950	3931	3.59450
3797	3.57944			3887	3.58961	3932	3.59461
3798	3.57956			3888	3.58973	3933	3.59472
3799	3.57967			3889	3.58984	3934	3.59483
3800	3.57978			3890	3.58995	3935	3.59494
3801	3.57990			3891	3.59006	3936	3.59506
3802	3.58001			3892	3.59017	3937	3.59517
3803	3.58013			3893	3.59028	3938	3.59528
3804	3.58024			3894	3.59040	3939	3.59539
3805	3.58035			3895	3.59051	3940	3.59550
3806	3.58047			3896	3.59062	3941	3.59561
3807	3.58058			3897	3.59073	3942	3.59572
3808	3.58070			3898	3.59084	3943	3.59583
3809	3.58081			3899	3.59095	3944	3.59594
3810	3.58093			3900	3.59006	3945	3.59605
3811	3.58104			3901	3.59118	3946	3.59616
3812	3.58115			3902	3.59129	3947	3.59627
3813	3.58127			3903	3.59140	3948	3.59638
3814	3.58138			3904	3.59151	3949	3.59649
3815	3.58149			3905	3.59162	3950	3.59660
3816	3.58161			3906	3.59173	3951	3.59671
3817	3.58172			3907	3.59184	3952	3.59682
3818	3.58184			3908	3.59195	3953	3.59693
3819	3.58195			3909	3.59207	3954	3.59704
3820	3.58206			3910	3.59218	3955	3.59715
3821	3.58218			3911	3.59229	3956	3.59726
3822	3.58229			3912	3.59240	3957	3.59737
3823	3.58240			3913	3.59251	3958	3.59748
3824	3.58252			3914	3.59262	3959	3.59759
3825	3.58263	3870	3.58771	3915	3.59273	3960	3.59770

N	Logar.	N.	Logar	N.	Logar.	N.	Logar.
3961	3.59780	4006	3.60271	4051	3.60756	4096	3.61236
3962	3.59791	4007	3.60282	4052	3.60767	4097	3.61247
3963	3.59802	4008	3.60293	4053	3.60778	4098	3.61257
3964	3.59813	4009	3.60304	4054	3.60788	4099	3.61268
3965	3.59824	4010	3.60314	4055	3.60799	4100	3.61278
3966	3.59835	4011	3.60325	4056	3.60810	4101	3.61289
3967	3.59846	4012	3.60336	4057	3.60821	4102	3.61300
3968	3.59857	4013	3.60347	4058	3.60831	4103	3.61310
3969	3.59868	4014	3.60358	4059	3.60842	4104	3.61321
3970	3.59879	4015	3.60369	4060	3.60853	4105	3.61331
3971	3.59890	4016	3.60379			4106	3.61342
3972	3.59901	4017	3.60390			4107	3.61352
3973	3.59912	4018	3.60401			4108	3.61363
3974	3.59923	4019	3.60412			4109	3.61374
3975	3.59934	4020	3.60423			4110	3.61384
3976	3.59945	4021	3.60433			4111	3.61395
3977	3.59956	4022	3.60444			4112	3.61405
3978	3.59966	4023	3.60455			4113	3.61416
3979	3.59977	4024	3.60466			4114	3.61426
3980	3.59988	4025	3.60477			4115	3.61437
3981	3.59999	4026	3.60487			4116	3.61448
3982	3.60010	4027	3.60498			4117	3.61458
3983	3.60021	4028	3.60509			4118	3.61469
3984	3.60032	4029	3.60520			4119	3.61479
3985	3.60043	4030	3.60531			4120	3.61490
3986	3.60054	4031	3.60541			4121	3.61500
3987	3.60065	4032	3.60552			4122	3.61511
3988	3.60076	4033	3.60563			4123	3.61521
3989	3.60086	4034	3.60574			4124	3.61532
3990	3.60097	4035	3.60584			4125	3.61542
3991	3.60108	4036	3.60595			4126	3.61553
3992	3.60119	4037	3.60606			4127	3.61563
3993	3.60130	4038	3.60617			4128	3.61574
3994	3.60141	4039	3.60627	4084	3.61109	4129	3.61584
3995	3.60152	4040	3.60638	4085	3.61119	4130	3.61595
3996	3.60163	4041	3.60649	4086	3.61130	4131	3.61606
3997	3.60173	4042	3.60660	4087	3.61140	4132	3.61616
3998	3.60184	4043	3.60670	4088	3.61151	4133	3.61627
3999	3.60195	4044	3.60681	4089	3.61162	4134	3.61637
4000	3.60206	4045	3.60692	4090	3.61172	4135	3.61648
4001	3.60217	4046	3.60703	4091	3.61183	4136	3.61658
4002	3.60228	4047	3.60713	4092	3.61194	4137	3.61669
4003	3.60239	4048	3.60724	4093	3.61204	4138	3.61679
4004	3.60249	4049	3.60735	4094	3.61215	4139	3.61690
4005	3.60260	4050	3.60746	4095	3.61225	4140	3.61700

4141

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
4141	3.61711	4186	3.62180	4231	3.62644	4276	3.63104
4142	3.61721	4187	3.62190	4232	3.62655	4277	3.63114
4143	3.61731	4188	3.62201	4233	3.62665	4278	3.63124
4144	3.61742	4189	3.62211	4234	3.62675	4279	3.63134
4145	3.61752	4190	3.62221	4235	3.62685	4280	3.63144
4146	3.61763	4191	3.62232	4236	3.62696	4281	3.63155
4147	3.61773	4192	3.62242	4237	3.62706	4282	3.63165
4148	3.61784	4193	3.62252	4238	3.62716	4283	3.63175
4149	3.61794	4194	3.62263	4239	3.62726	4284	3.63185
4150	3.61805	4195	3.62273	4240	3.62737	4285	3.63195
4151	3.61815	4196	3.62284	4241	3.62747	4286	3.63205
4152	3.61826	4197	3.62294	4242	3.62757	4287	3.63215
4153	3.61836	4198	3.62304	4243	3.62767	4288	3.63225
4154	3.61847	4199	3.62315	4244	3.62778	4289	3.63236
4155	3.61857	4200	3.62325	4245	3.62788	4290	3.63246
4156	3.61868	4201	3.62335	4246	3.62798	4291	3.63256
4157	3.61878	4202	3.62346	4247	3.62808	4292	3.63266
4158	3.61888	4203	3.62356	4248	3.62818	4293	3.63276
4159	3.61899	4204	3.62366	4249	3.62829	4294	3.63286
4160	3.61909	4205	3.62377	4250	3.62839	4295	3.63296
4161	3.61920	4206	3.62387	4251	3.62849	4296	3.63306
4162	3.61930	4207	3.62397	4252	3.62859	4297	3.63317
4163	3.61941	4208	3.62408	4253	3.62870	4298	3.63327
4164	3.61951	4209	3.62418	4254	3.62880	4299	3.63337
4165	3.61962	4210	3.62428	4255	3.62890	4300	3.63347
4166	3.61972	4211	3.62439	4256	3.62900	4301	3.63357
4167	3.61982	4212	3.62449	4257	3.62910	4302	3.63367
4168	3.61993	4213	3.62459	4258	3.62921	4303	3.63377
4169	3.62003	4214	3.62469	4259	3.62931	4304	3.63387
4170	3.62014	4215	3.62480	4260	3.62941	4305	3.63397
4171	3.62024	4216	3.62490	4261	3.62951	4306	3.63407
4172	3.62034	4217	3.62500	4262	3.62961	4307	3.63417
4173	3.62045	4218	3.62511	4263	3.62972	4308	3.63428
4174	3.62055	4219	3.62521	4264	3.62982	4309	3.63438
4175	3.62066	4220	3.62531	4265	3.62992	4310	3.63448
4176	3.62076	4221	3.62542	4266	3.63002	4311	3.63458
4177	3.62086	4222	3.62552	4267	3.63012	4312	3.63468
4178	3.62097	4223	3.62562	4268	3.63022	4313	3.63478
4179	3.62107	4224	3.62572	4269	3.63033	4314	3.63488
4180	3.62118	4225	3.62583	4270	3.63043	4315	3.63498
4181	3.62128	4226	3.62593	4271	3.63053	4316	3.63508
4182	3.62138	4227	3.62603	4272	3.63063	4317	3.63518
4183	3.62149	4228	3.62614	4273	3.63073	4318	3.63528
4184	3.62159	4229	3.62624	4274	3.63083	4319	3.63538
4185	3.62170	4230	3.62634	4275	3.63094	4320	3.63548

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
4321	3.63558	4366	3.64008	4411	3.64454	4456	3.64895
4322	3.63568	4367	3.64018	4412	3.64464	4457	3.64904
4323	3.63579	4368	3.64028	4413	3.64473	4458	3.64914
4324	3.63589	4369	3.64038	4414	3.64483	4459	3.64924
4325	3.63599	4370	3.64048	4415	3.64493	4460	3.64933
4326	3 09	4371	3.64058	4416	3.64503	4461	3.64943
4327	3 19	4372	3.64068	4417	3.64513	4462	3.64953
4328	3 29	4373	3.64078	4418	3.64523	4463	3.64963
4329	3 39	4374	3.64088	4419	3.64532	4464	3.64972
4330	3 49	4375	3.64098	4420	3.64542	4465	3.64982
4331	3.63659	4376	3.64108	4421	3.64552	4466	3.64992
4332	3.63669	4377	3.64118	4422	3.64562	4467	3.65002
4333	3.63679	4378	3.64128	4423	3.64572	4468	3.65011
4334	3.63689	4379	3.64137	4424	3.64582	4469	3.65021
4335	3.63699	4380	3.64147	4425	3.64591	4470	3.65031
4336	3.63709	4381	3.64157	4426	3.64601	4471	3.65040
4337	3.63719	4382	3.64167	4427	3.64611	4472	3.65050
4338	3.63729	4383	3.64177	4428	3.64621	4473	3.65060
4339	3.63739	4384	3.64187	4429	3.64631	4474	3.65070
4340	3.63749	4385	3.64197	4430	3.64640	4475	3.65079
4341	3.63759	4386	3.64207	4431	3.64650	4476	3.65089
4342	3.63769	4387	3.64217	4432	3.64660	4477	3.65099
4343	3.63779	4388	3.64227	4433	3.64670	4478	3.65108
4344	3.63789	4389	3.64237	4434	3.64680	4479	3.65118
4345	3.63799	4390	3.64246	4435	3.64689	4480	3.65128
4346	3.63809	4391	3.64256	4436	3.64699	4481	3.65137
4347	3.63819	4392	3.64266	4437	3.64709	4482	3.65147
4348	3.63829	4393	3.64276	4438	3.64719	4483	3.65157
4349	3.63839	4394	3.64286	4439	3.64729	4484	3.65167
4350	3.63849	4395	3.64296	4440	3.64738	4485	3.65176
4351	3.63859	4396	3.64306	4441	3.64748	4486	3.65186
4352	3.63869	4397	3.64316	4442	3.64758	4487	3.65196
4353	3.63879	4398	3.64326	4443	3.64768	4488	3.65205
4354	3.63889	4399	3.64335	4444	3.64777	4489	3.65215
4355	3.63899	4400	3.64345	4445	3.64787	4490	3.65225
4356	3.63909	4401	3.64355	4446	3.64797	4491	3.65234
4357	3.63919	4402	3.64365	4447	3.64807	4492	3.65244
4358	3.63929	4403	3.64375	4448	3.64816	4493	3.65254
4359	3.63939	4404	3.64385	4449	3.64826	4494	3.65263
4360	3.63949	4405	3.64395	4450	3.64836	4495	3.65273
4361	3.63959	4406	3.64404	4451	3.64846	4496	3.65283
4362	3.63969	4407	3.64414	4452	3.64856	4497	3.65292
4363	3.63979	4408	3.64424	4453	3.64865	4498	3.65302
4364	3.63988	4409	3.64434	4454	3.64875	4499	3.65312
4365	3.63998	4410	3.64444	4455	3.64885	4500	3.65321

N.	Logar.	N	Logar.	N.	Logar.	N.	Logar.
4501	3.65331	4546	3.65763	4591	3.66191	4636	3.66614
4502	3.65341	4547	3.65773	4592	3.66200	4637	3.66624
4503	3.65350	4548	3.65782	4593	3.66210	4638	3.66633
4504	3.65360	4549	3.65792	4594	3.66219	4639	3.66642
4505	3.65369	4550	3.65801	4595	3.66229	4640	3.66652
4506	3.65379	4551	3.65811	4596	3.66238	4641	3,66661
4507	3.65389	4552	3.65820	4597	3.66247	4642	3.66671
4508	3.65398	4553	3.65830	4598	3.66257	4643	3.66680
4509	3.65408	4554	3.65839	4559	3.66266	4644	3.66689
4510	3.65418	4555	3.65849	4600	3.66276	4645	3.66699
4511	3.65427	4556	3.65858	4601	3.66285	4646	3.66708
4512	3.65437	4557	3.65868	4602	3.66295	4647	3.66717
4513	3.65447	4558	3.65877	4603	3.66304	4648	3.66727
4514	3.65456	4559	3.65887	4604	3.66314	4649	3.66736
4515	3.65466	4560	3.65896	4605	3.66323	4650	3.66745
4516	3.65475	4561	3.65906	4606	3.66332	4651	3.66755
4517	3.65485	4562	3.65916	4607	3.66342	4652	3.66764
4518	3.65495	4563	3.65925	4608	3.66351	4653	3.66773
4519	3.65504	4564	3.65935	4609	3.66361	4654	3.66783
4520	3.65514	4565	3.65944	4610	3.66370	4655	3.66792
4521	3.65523	4566	3.65954	4611	3.66380	4656	3.66801
4522	3.65533	4567	3.65963	4612	3.66389	4657	3.66811
4523	3.65543	4568	3.65973	4613	3.66398	4658	3.66820
4524	3.65552	4569	3.65982	4614	3.66408	4659	3.66829
4525	3.65562	4570	3.65992	4615	3.66417	4660	3.66839
4526	3.65571	4571	3.66001	4616	3.66427	4661	3.66848
4527	3.65581	4572	3.66011	4617	3.66436	4662	3.66857
4528	3.65591	4573	3.66020	4618	3.66445	4663	3.66867
4529	3.65600	4574	3.66030	4619	3.66455	4664	3.66876
4530	3.65610	4575	3.66039	4620	3.66464	4665	3.66885
4531	3.65619	4576	3.66049	4621	3.66474	4666	3.66894
4532	3.65629	4577	3.66058	4622	3.66483	4667	3.66904
4533	3.65639	4578	3.66068	4623	3.66492	4668	3.66913
4534	3.65648	4579	3.66077	4624	3.66502	4669	3.66922
4535	3.65658	4580	3.66087	4625	3.66511	4670	3.66932
4536	3.65667	4581	3.66096	4626	3.66521	4671	3.66941
4537	3.65677	4582	3.66106	4627	3.66530	4672	3.66950
4538	3.65686	4583	3.66115	4628	3.66539	4673	3.66960
4539	3.65696	4584	3.66124	4629	3.66549	4674	3.66969
4540	3.65706	4585	3.66134	4630	3.66558	4675	3.66978
4541	3.65715	4586	3.66143	4631	3.66567	4676	3.66987
4542	3.65725	4587	3.66153	4632	3.66577	4677	3.66997
4543	3.65734	4588	3.66162	4633	3.66586	4678	3.67006
4544	3.65744	4589	3.66172	4634	3.66596	4679	3.67015
4545	3.65753	4590	3.66181	4635	3.66605	4680	3.67025

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
4681	3.67034	4726	3.67449	4771	3.67861	4816	3.68269
4682	3.67043	47[illegible]	3.67459	4772	3.67870	4817	3.68278
4683	3.67052	4728	3.67468	4773	3.67879	4818	3.68287
4684	3.67062	4729	3.67477	4774	3.67888	4819	3.68296
4685	3.67071	4730	3.67486	4775	3.67897	4820	3.68305
4686	3.67080	4731	3.67495	4776	3.67906	4821	3.68314
4687	3.67090	4732	3.67504	4777	3.67916	4822	3.68323
4688	3.67099	4733	3.67514	4778	3.67925	4823	3.68332
4689	3.67108	4734	3.67523	4779	3.67934	4824	3.68341
4690	3.67117	4735	3.67532	4780	3.67943	4825	3.68350
4691	3.67127	4736	3.67541	4781	3.67952	4826	3.68359
4692	3.67136	4737	3.67550	4782	3.67961	4827	3.68368
4693	3.67145	4738	3.67560	4783	3.67970	4828	3.68377
4694	3.67154	4739	3.67569	4784	3.67979	4829	3.68386
4695	3.67164	4740	3.67578	4785	3.67988	4830	3.68395
4696	3.67173	4741	3.67587	4786	3.67997	4831	3.68404
4697	3.67182	4742	3.67596	4787	3.68006	4832	3.68413
4698	3.67191	4743	3.67605	4788	3.68015	4833	3.68422
4699	3.67201	4744	3.67614	4789	3.68024	4834	3.68431
4700	3.67210	4745	3.67624	4790	3.68034	4835	3.68440
4701	3.67219	4746	3.67633	4791	3.68043	4836	3.68449
4702	3.67228	4747	3.67642	4792	3.68052	4837	3.68458
4703	3.67238	4748	3.67651	4793	3.68061	4838	3.68467
4704	3.67247	4749	3.67660	4794	3.68070	4839	3.68476
4705	3.67256	4750	3.67669	4795	3.68079	4840	3.68485
4706	3.67265	4751	3.67679	4796	3.68088	4841	3.68494
4707	3.67274	4752	3.67688	4797	3.68097	4842	3.68502
4708	3.67284	4753	3.67697	4798	3.68106	4843	3.68511
4709	3.67293	4754	3.67706	4799	3.68115	4844	3.68520
4710	3.67302	4755	3.67715	4800	3.68124	4845	3.68529
4711	3.67311	4756	3.67724	4801	3.68133	4846	3.68538
4712	3.67321	4757	3.67733	4802	3.68142	4847	3.68547
4713	3.67330	4758	3.67742	4803	3.68151	4848	3.68556
4714	3.67339	4759	3.67752	4804	3.68160	4849	3.68565
4715	3.67348	4760	3.67761	4805	3.68169	4850	3.68574
4716	3.67357	4761	3.67770	4806	3.68178	4851	3.68583
4717	3.67367	4762	3.67779	4807	3.68187	4852	3.68592
4718	3.67376	4763	3.67788	4808	3.68196	4853	3.68601
4719	3.67385	4764	3.67797	4809	3.68205	4854	3.68610
4720	3.67394	4765	3.67806	4810	3.68215	4855	3.68619
4721	3.67403	4766	3.67815	4811	3.68224	4856	3.68628
4722	3.67413	4767	3.67825	4812	3.68233	4857	3.68637
4723	3.67422	4768	3.67834	4813	3.68242	4858	3.68646
4724	3.67431	4769	3.67843	4814	3.68251	4859	3.68655
4[illegible]	[illegible]67440	4770	3.67852	4815	3.68260	4860	3.68664

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
4861	3.68673	4906	3.69073	4951	3.69469	4996	3.69862
4862	3.68681	4907	3.69082	4952	3.69478	4997	3.69871
4863	3.68690	4908	3.69090	4953	3.69487	4998	3.69880
4864	3.68699	4909	3.69099	4954	3.69496	4999	3.69888
4865	3.68708	4910	3.69108	4955	3.69504	5000	3.69897
4866	3.68717	4911	3.69117	4956	3.69513	5001	3.69906
4867	3.68726	4912	3.69126	4957	3.69522	5002	3.69914
4868	3.68735	4913	3.69135	4958	3.69531	5003	3.69923
4869	3.68744	4914	3.69144	4959	3.69539	5004	3.69932
4870	3.68753	4915	3.69152	4960	3.69548	5005	3.69940
4871	3.68762	4916	3.69161	4961	3.69557	5006	3.69949
4872	3.68771	4917	3.69170	4962	3.69566	5007	3.69958
4873	3.68780	4918	3.69179	4963	3.69574	5008	3.69966
4874	3.68789	4919	3.69188	4964	3.69583	5009	3.69975
4875	3.68797	4920	3.69197	4965	3.69592	5010	3.69984
4876	3.68806	4921	3.69205	4966	3.69601	5011	3.69992
4877	3.68815	4922	3.69214	4967	3.69609	5012	3.70001
4878	3.68824	4923	3.69223	4968	3.69618	5013	3.70010
4879	3.68833	4924	3.69232	4969	3.69627	5014	3.70018
4880	3.68842	4925	3.69241	4970	3.69636	5015	3.70027
4881	3.68851	4926	3.69249	4971	3.69644	5016	3.70036
4882	3.68860	4927	3.69258	4972	3.69653	5017	3.70044
4883	3.68869	4928	3.69267	4973	3.69662	5018	3.70053
4884	3.68878	4929	3.69276	4974	3.60671	5019	3.70062
4885	3.68886	4930	3.69285	4975	3.69679	5020	3.70070
4886	3.68895	4931	3.69294	4976	3.69688	5021	3.70079
4887	3.68904	4932	3.69302	4977	3.69697	5022	3.79088
4888	3.68913	4933	3.69311	4978	3.69705	5023	3.70096
4889	3.68922	4934	3.69320	4979	3.69714	5024	3.70105
4890	3.68931	4935	3.69329	4980	3.69723	5025	3.70114
4891	3.68940	4936	3.69338	4981	3.69732	5026	3.70122
4892	3.68949	4937	3.69346	4982	3.69740	5027	3.70131
4893	3.68958	4938	3.69355	4983	3.69749	5028	3.70140
4894	3.68966	4939	3.69364	4984	3.69758	5029	3.70148
4895	3.68975	4940	3.69373	4985	3.69767	5030	3.70157
4896	3.68984	4941	3.69381	4986	3.69775	5031	3.70165
4897	3.68993	4942	3.69390	4987	3.69784	5032	3.70174
4898	3.69002	4943	3.69399	4988	3.69793	5033	3.70183
4899	3.69011	4944	3.69408	4989	3.69801	5034	3.70191
4900	3.69020	4945	3.69417	4990	3.69810	5035	3.70200
4901	3.69028	4946	3.69425	4991	3.69819	5036	3.70209
4902	3.69037	4947	3.69434	4992	3.69827	5037	3.70217
4903	3.69046	4948	3.69443	4993	3.69836	5038	5.70226
4904	3.69055	4949	3.69452	4994	3.69845	5039	3.70234
4905	3.69064	4950	3.69461	4995	3.69854	5040	3.70243

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
5041	3.70252	5086	3.70638	5131	3.71020	5176	3.71399
5042	3.70260	5087	3.70646	5132	3.71028	5177	3.71408
5043	3.70269	5088	3.70655	5133	3.71037	5178	3.71416
5044	3.70278	5089	3.70663	5134	3.71046	5179	3.71425
5045	3.70286	5090	3.70672	5135	3.71054	5180	3.71433
5046	3.70295	5091	3.70680	5136	3.71063	5181	3.71441
5047	3.70303	5092	3.70689	5137	3.71071	5182	3.71450
5048	3.70312	5093	3.70697	5138	3.71079	5183	3.71458
5049	3.70321	5094	3.70706	5139	3.71088	5184	3.71467
5050	3.70329	5095	3.70714	5140	3.71096	5185	3.71475
5051	3.70338	5096	3.70723	5141	3.71105	5186	3.71483
5052	3.70346	5097	3.70731	5142	3.71113	5187	3.71492
5053	3.70355	5098	3.70740	5143	3.71122	5188	3.71500
5054	3.70364	5099	3.70749	5144	3.71130	5189	3.71508
5055	3.70272	5100	3.70757	5145	3.71139	5190	3.71517
5056	3.70381	5101	3.70766	5146	3.71147	5191	3.71525
5057	3.70389	5102	3.70774	5147	3.71155	5192	3.71533
5058	3.70398	5103	3.70783	5148	3.71164	5193	3.71542
5059	3.70406	5104	3.70791	5149	3.71172	5194	3.71550
5060	3.70415	5105	3.70800	5150	3.71181	5195	3.71559
5061	3.70424	5106	3.70808	5151	3.71189	5196	3.71567
5062	3.70432	5107	3.70817	5152	3.71198	5197	3.71575
5063	3.70441	5108	3.70825	5153	3.71206	5198	3.71584
5064	3.70449	5109	3.70834	5154	3.71214	5199	3.71592
5065	3.70458	5110	3.70842	5155	3.71223	5200	3.71600
5066	3.70466	5111	3.70851	5156	3.71231	5201	3.71609
5067	3.70475	5112	3.70859	5157	3.71240	5202	3.71617
5068	3.70484	5113	3.70868	5158	3.71248	5203	3.71625
5069	3.70492	5114	3.70876	5159	3.71257	5204	3.71634
5070	3.70501	5115	3.70885	5160	3.71265	5205	3.71642
5071	3.70509	5116	3.70893	5161	3.71273	5206	3.71650
5072	3.70518	5117	3.70902	5162	3.71282	5207	3.71659
5073	3.70526	5118	3.70910	5163	3.71290	5208	3.71667
5074	3.70535	5119	3.70919	5164	3.71299	5209	3.71675
5075	3.70544	5120	3.70927	5165	3.71307	5210	3.71684
5076	3.70552	5121	3.70935	5166	3.71315	5211	3.71692
5077	3.70561	5122	3.70944	5167	3.71324	5212	3.71700
5078	3.70569	5123	3.70952	5168	3.71332	5213	3.71709
5079	3.70578	5124	3.70961	5169	3.71341	5214	3.71717
5080	3.70586	5125	3.70969	5170	3.71349	5215	3.71725
5081	3.70595	5126	3.70978	5171	3.71357	5216	3.71734
5082	3.70603	5127	3.70986	5172	3.71366	5217	3.71742
5083	3.70612	5128	3.70995	5173	3.71374	5218	3.71750
5084	3.70621	5129	3.71003	5174	3.71383	5219	3.71759
5085	3.70629	5130	3.71012	5175	3.71391	5220	3.71767

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
5221	3.71775	5266	3.72148	5311	3.72518	5356	3.72884
5222	3.71784	5267	3.72156	5312	3.72526	5357	3.72892
5223	3.71792	5268	3.72165	5313	3.72534	5358	3.72900
5224	3.71800	5269	3.72173	5314	3.72542	5359	3.72908
5225	3.71809	5270	3.72181	5315	3.72550	5360	3.72916
5226	3.71817	5271	3.72189	5316	3.72559	5361	3.72925
5227	3.71825	5272	3.72198	5317	3.72567	5362	3.72933
5228	3.71834	5273	3.72206	5318	3.72575	5363	3.72941
5229	3.71842	5274	3.72214	5319	3.72583	5364	3.72949
5230	3.71850	5275	3.72222	5320	3.72591	5365	3.72957
5231	3.71858	5276	3.72230	5321	3.72599	5366	3.72965
5232	3.71867	5277	3.72239	5322	3.72607	5367	3.72973
5233	3.71875	5278	3.72247	5323	3.72616	5368	3.72981
5234	3.71883	5279	3.72255	5324	3.72624	5369	3.72989
5235	3.71892	5280	3.72263	5325	3.72632	5370	3.72997
5236	3.71900	5281	3.72272	5326	3.72640	5371	3.73006
5237	3.71908	5282	3.72280	5327	3.[illegible]8	5372	3.73014
5238	3.71917	5283	3.72288	5328	3.[illegible]6	5373	3.73022
5239	3.71925	5284	3.72296	5329	3.[illegible]5	5374	3.73030
5240	3.71933	5285	3.72305	5330	3.[illegible]73	5375	3.73038
5241	3.71941	5286	3.72313	5331	3.72681	5376	3.73046
5242	3.71950	5287	3.72321	5332	3.72689	5377	3.73054
5243	3.71958	5288	3.72329	5333	3.72697	5378	3.73062
5244	3.71966	5289	3.72337	3334	3.72705	5379	3.73070
5245	3.71975	5290	3.72346	5335	3.72713	5380	3.73078
5246	3.71983	5291	3.72354	5336	3.72722	5381	3.73086
5247	3.71991	5292	3.72362	5337	3.72730	5382	3.73094
5248	3.71999	5293	3.72370	5338	3.72738	5383	3.73102
5249	3.72008	5294	3.72378	5339	3.72746	5384	3.73111
5250	3.72016	5295	3.72387	5340	3.72754	5385	3.73119
5251	3.72024	5296	3.72395	5341	3.72762	5386	3.73127
5252	3.72032	5297	3.72403	5342	3.72770	5387	3.73135
5253	3.72041	5298	3.72411	5343	3.72779	5388	3.73143
5254	3.72049	5299	3.72419	5344	3.72787	5389	3.73151
5255	3.72057	5300	3.72428	5345	3.72795	5390	3.73159
5256	3.72066	5301	3.72436	5346	3.72803	5391	3.73167
5257	3.72074	5302	3.72444	5347	3.72811	5392	3.73175
5258	3.72082	5303	3.72452	5348	3.72819	5393	3.73183
5259	3.72090	5304	3.72460	5349	3.72827	5394	3.73191
5260	3.72099	5305	3.72469	5350	3.72835	5395	3.73199
5261	3.72107	5306	3.72477	5351	3.72843	5396	3.73207
5262	3.72115	5307	3.72485	5352	3.72852	5397	3.73215
5263	3.72123	5308	3.72493	5353	3.72860	5398	3.73223
5264	3.72132	5309	3.72501	5354	3.72868	5399	3.73231
5265	3.72140	5310	3.72509	5355	3.72876	5400	3.73239

5401

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
5401	3.73247	5446	3.73608	5491	3.73965	5536	3.74320
5402	3.73255	5447	3.73616	5492	3.73973	5537	3.74327
5403	3.73264	5448	3.73624	5493	3.73981	5538	3.74335
5404	3.73272	5449	3.73632	5494	3.73989	5539	3.74343
5405	3.73280	5450	3.73640	5495	3.73997	5540	3.74351
5406	3.73288	5451	3.73648	5496	3.74005	5541	3.74359
5407	3.73296	5452	3.73656	5497	3.74013	5542	3.74367
5408	3.73304	5453	3.73664	5498	3.74020	5543	3.74374
5409	3.73312	5454	3.73672	5499	3.74028	5544	3.74382
5410	3.73320	5455	3.73679	5500	3.74036	5545	3.74390
5411	3.73328	5456	3.73687	5501	3.74044	5546	3.74398
5412	3.73336	5457	3.73695	5502	3.74052	5547	3.74406
5413	3.73344	5458	3.73703	5503	3.74060	5548	3.74414
5414	3.73352	5459	3.73711	5504	3.74068	5549	3.74421
5415	3.73360	5460	3.73719	5505	3.74076	5550	3.74429
5416	3.73368	5461	3.73727	5506	3.74084	5551	3.74437
5417	3.73376	5462	3.73735	5507	3.74092	5552	3.74445
5418	3.73384	5463	3.73743	5508	3.74099	5553	3.74453
5419	3.73392	5464	3.73751	5509	3.74107	5554	3.74461
5420	3.73400	5465	3.73759	5510	3.74115	5555	3.74468
5421	3.73408	5466	3.73767	5511	3.74123	5556	3.74476
5422	3.73416	5467	3.73775	5512	3.74131	5557	3.74484
5423	3.73424	5468	3.73783	5513	3.74139	5558	3.74492
5424	3.73432	5469	3.73791	5514	3.74147	5559	3.74500
5425	3.73440	5470	3.73799	5515	3.74156	5560	3.74507
5426	3.73448	5471	3.73807	5516	3.74162	5561	3.74515
5427	3.73456	5472	3.73815	5517	3.74170	5562	3.74523
5428	3.73464	5473	3.73823	5518	3.74178	5563	3.74531
5429	3.73472	5474	3.73830	5519	3.74186	5564	3.74539
5430	3.73480	5475	3.73838	5520	3.74194	5565	3.74547
5431	3.73488	5476	3.73846	5521	3.74202	5566	3.74554
5432	3.73496	5477	3.73854	5522	3.74210	5567	3.74562
5433	3.73504	5478	3.73862	5523	3.74218	5568	3.74570
5434	3.73512	5479	3.73870	5524	3.74225	5569	3.74578
5435	3.73520	5480	3.73878	5525	3.74233	5570	3.74586
5436	3.73528	5481	3.73886	5526	3.74241	5571	3.74593
5437	3.73536	5482	3.73894	5527	3.74249	5572	3.74601
5438	3.73544	5483	3.73902	5528	3.74257	5573	3.74609
5439	3.73552	5484	3.73909	5529	3.74265	5574	3.74617
5440	3.73560	5485	3.73918	5530	3.74273	5575	3.74624
5441	3.73568	5486	3.73926	5531	3.74280	5576	3.74632
5442	3.73576	5487	3.73934	5532	3.74288	5577	3.74640
5443	3.73584	5488	3.73941	5533	3.74296	5578	3.74648
5444	3.73592	5489	3.73949	5534	3.74304	5579	3.74656
5445	3.73600	5490	3.73957	5535	3.74312	5580	3.74663

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
5761	3.76050	5806	3.76388	5851	3.76723	5896	3.77056
5762	3.76057	5807	3.76395	5852	3.76730	5897	3.77063
5763	3.76065	5808	3.76403	5853	3.76738	5898	3.77070
5764	3.76072	5809	3.76410	5854	3.76745	5899	3.77078
5765	3.76080	5810	3.76418	5855	3.76753	5900	3.77085
5766	3.76087	5811	3.76425	5856	3.76760	5901	3.77093
5767	3.76095	5812	3.76433	5857	3.76768	5902	3.77100
5768	3.76103	5813	3.76440	5858	3.76775	5903	3.77107
5769	3.76110	5814	3.76448	5859	3.76782	5904	3.77115
5770	3.76118	5815	3.76455	5860	3.76790	5905	3.77122
5771	3.76125	5816	3.76462	5861	3.76797	5906	3.77129
5772	3.76133	5817	3.76470	5862	3.76805	5907	3.77137
5773	3.76140	5818	3.76477	5863	3.76812	5908	3.77144
5774	3.76148	5819	3.76485	5864	3.76819	5909	3.77151
5775	3.76155	5820	3.76492	5865	3.76827	5910	3.77159
5776	3.76163	5821	3.76500	5866	3.76834	5911	3.77166
5777	3.76170	5822	3.76507	5867	3.76842	5912	3.77173
5778	3.76178	5823	3.76515	5868	3.76849	5913	3.77181
5779	3.76185	5824	3.76522	5869	3.76856	5914	3.77188
5780	3.76193	5825	3.76530	5870	3.76864	5915	3.77195
5781	3.76200	5826	3.76537	5871	3.76871	5916	3.77203
5782	3.76208	5827	3.76545	5872	3.76879	5917	3.77210
5783	3.76215	5828	3.76552	5873	3.76886	5918	3.77218
5784	3.76223	5829	3.76559	3874	3.76893	5919	3.77225
5785	3.76230	5830	3.76567	5875	3.76901	5920	3.77232
5786	3.76238	5831	3.76574	5876	3.76908	5921	3.77240
5787	3.76245	5832	3.76582	5877	3.76916	5922	3.77247
5788	3.76253	5833	3.76589	5878	3.76923	5923	3.77254
5789	3.76260	5834	3.76597	5879	3.76930	5924	3.77262
5790	3.76268	5835	3.76604	5880	3.76938	5925	3.77269
5791	3.76275	5836	3.76612	5881	3.76945	5926	3.77276
5792	3.76283	5837	3.76619	5882	3.76953	5927	3.77283
5793	3.76290	5838	3.76626	5883	3.76960	5928	3.77291
5794	3.76298	5839	3.76634	5884	3.76967	5929	3.77298
5795	3.76305	5840	3.76641	5885	3.76975	5930	3.77305
5796	3.76313	5841	3.76649	5886	3.76982	5931	3.77313
5797	3.76320	5842	3.76656	5887	3.76989	5932	3.77320
5798	3.76328	5843	3.76664	5888	3.76997	5933	3.77327
5799	3.76335	5844	3.76671	5889	3.77004	5934	3.77335
5800	3.76343	5845	3.76678	5890	3.77012	5935	3.77342
5801	3.76350	5846	3.76686	5891	3.77019	5936	3.77349
5802	3.76358	5847	3.76693	5892	3.77026	5937	3.77357
5803	3.76365	5848	3.76701	5893	3.77034	5938	3.77364
5804	3.76373	5849	3.76708	5894	3.77041	5939	3.77371
5805	3.76380	5850	3.76716	5895	3.77048	5940	3.77379

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
5941	3.77386	5986	3.77714	6031	3.78039	6076	3.78362
5942	3.77393	5987	3.77721	6032	3.78046	6077	3.78369
5943	3.77401	5988	3.77728	6033	3.78053	6078	3.78376
5944	3.77408	5989	3.77735	6034	3.78061	6079	3.78383
5945	3.77415	5990	3.77743	6035	3.78068	6080	3.78390
5946	3.77422	5991	3.77750	6036	3.78075	6081	3.78398
5947	3.77430	5992	3.77757	6037	3.78082	6082	3.78405
5948	3.77437	5993	3.77764	6038	3.78089	6083	3.78412
5949	3.77444	5994	3.77772	6039	3.78097	6084	3.78419
5950	3.77452	5995	3.77779	6040	3.78104	6085	3.78426
5951	3.77459	5996	3.77786	6041	3.78110	6086	3.78433
5952	3.77466	5997	3.77793	6042	3.78118	6087	3.78440
5953	3.77474	5998	3.77801	6043	3.78125	6088	3.78447
5954	3.77481	5999	3.77808	6044	3.78132	6089	3.78455
5955	3.77488	6000	3.77815	6045	3.78140	6090	3.78462
5956	3.77495	6001	3.77822	6046	3.78147	6091	3.78469
5957	3.77503	6002	3.77830	6047	3.78154	6092	3.78476
5958	3.77510	6003	3.77837	6048	3.78161	6093	3.78483
5959	3.77517	6004	3.77844	6049	3.78168	6094	3.78490
5960	3.77525	6005	3.77851	6050	3.78176	6095	3.78497
5961	3.77532	6006	3.77859	6051	3.78183	6096	3.78505
5962	3.77539	6007	3.77866	6052	3.78190	6097	3.78512
5963	3.77546	6008	3.77873	6053	3.78197	6098	3.78519
5964	3.77554	6009	3.77880	6054	3.78204	6099	3.78553
5965	3.77561	6010	3.77887	6055	3.78211	6100	3.78533
5966	3.77568	6011	3.77895	6056	3.78219	6101	3.78540
5967	3.77576	6012	3.77902	6057	3.78226	6102	3.78547
5968	3.77583	6013	3.77909	6058	3.78233	6103	3.78554
5969	3.77590	6014	3.77916	6059	3.78240	6104	3.78561
5970	3.77597	6015	3.77924	6060	3.78247	6105	3.78569
5971	3.77605	6016	3.77931	6061	3.78254	6106	3.78576
5972	3.77612	6017	3.77938	6062	3.78262	6107	3.78583
5973	3.77619	6018	3.77945	6063	3.78269	6108	3.78590
5974	3.77627	6019	3.77952	6064	3.78276	6109	3.78597
5975	3.77634	6020	3.77960	6065	3.78283	6110	3.78604
5976	3.77641	6021	3.77967	6066	3.78290	6111	3.78611
5977	3.77648	6022	3.77974	6067	3.78297	6112	3.78618
5978	3.77656	6023	3.77981	6068	3.78305	6113	3.78625
5979	3.77663	6024	3.77989	6069	3.78312	6114	3.78633
5980	3.77670	6025	3.77996	6070	3.78319	6115	3.78640
5981	3.77677	6026	3.78003	6071	3.78326	6116	3.78647
5982	3.77685	6027	3.78010	6072	3.78333	6117	3.78654
5983	3.77692	6028	3.78017	6073	3.78340	6118	3.78661
5984	3.77699	6029	3.78025	6074	3.78347	6119	3.78668
5985	3.77706	6030	3.78032	6075	3.78355	6120	3.78675

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
6121	3.78682	6166	3.79000	6211	3.79316	6256	3.79630
6122	3.78689	6167	3.79007	6212	3.79323	6257	3.79637
6123	3.78696	6168	3.79014	6213	3.79330	6258	3.79644
6124	3.78704	6169	3.79021	6214	3.79337	6259	3.79651
6125	3.78711	6170	3.79029	6215	3.79344	6260	3.79657
6126	3.78718	6171	3.79036	6216	3.79351	6261	3.79664
6127	3.78725	6172	3.79043	6217	3.79358	6262	3.79671
6128	3.78732	6173	3.79050	6218	3.79365	6263	3.79678
6129	3.78739	6174	3.79057	6219	3.79372	6264	3.79685
6130	3.78746	6175	3.79064	6220	3.79379	6265	3.79692
6131	3.78753	6176	3.79071	6221	3.79386	6266	3.79699
6132	3.78760	6177	3.79078	6222	3.79393	6267	3.79706
6133	3.78767	6178	3.79085	6223	3.79400	6268	3.79713
6134	3.78774	6179	3.79092	6224	3.79407	6269	3.79720
6135	3.78781	6180	3.79099	6225	3.79414	6270	3.79727
6136	3.78789	6181	3.79106	6226	3.79421	6271	3.79734
6137	3.78796	6182	3.79113	6227	3.79428	6272	3.79741
6138	3.78803	6183	3.79120	6228	3.79432	6273	3.79748
6139	3.78810	6184	3.79127	6229	3.79442	6274	3.79754
6140	3.78817	6185	3.79134	6230	3.79449	6275	3.79761
6141	3.78824	6186	3.79141	6231	3.79456	6276	3.79768
6142	3.78831	6187	3.79148	6232	3.79463	6277	3.79775
6143	3.78838	6188	3.79155	6233	3.79470	6278	3.79782
6144	3.78845	6189	3.79162	6234	3.79477	6279	3.79789
6145	3.78852	6190	3.79169	6235	3.79484	6280	3.79796
6146	3.78859	6191	3.79176	6236	3.79491	6281	3.79803
6147	3.78866	6192	3.79183	6237	3.79498	6282	3.79810
6148	3.78873	6193	3.79190	6238	3.79505	6283	3.79817
6149	3.78880	6194	3.79197	6239	3.79512	6284	3.79824
6150	3.78888	6195	3.79204	6240	3.79518	6285	3.79831
6151	3.78895	6196	3.79211	6241	3.79525	6286	3.79837
6152	3.78902	6197	3.79218	6242	3.79532	6287	3.79844
6153	3.78909	6198	3.79225	6243	3.79539	6288	3.79851
6154	3.78916	6199	3.79232	6244	3.79546	6289	3.79858
6155	3.78923	6200	3.79239	6245	3.79553	6290	3.79865
6156	3.78930	6201	3.79246	6246	3.79560	6291	3.79872
6157	3.78937	6202	3.79253	6247	3.79567	6292	3.79879
6158	3.78944	6203	3.79260	6248	3.79574	6293	3.79886
6159	3.78951	6204	3.79267	6249	3.79581	6294	3.79893
6160	3.78958	6205	3.79274	6250	3.79588	6295	3.79900
6161	3.78965	6206	3.79281	6251	3.79595	6296	3.79906
6162	3.78972	6207	3.79288	6252	3.79602	6297	3.79913
6163	3.78979	6208	3.79295	6253	3.79609	6298	3.79920
6164	3.78986	6209	3.79302	6254	3.79616	6299	3.79927
6165	3.78993	6210	3.79309	6255	3.79623	6300	3.79934

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
6301	3.79941	6346	3.80250	6391	3.80557	6436	3.80862
6302	3.79948	6347	3.80257	6392	3.80564	6437	3.80868
6303	3.79955	6348	3.80264	6393	3.80570	6438	3.80875
6304	3.79962	6349	3.80271	6394	3.80577	6439	3.80882
6305	3.79968	6350	3.80277	6395	3.80584	6440	3.80889
6306	3.79975	6351	3.80284	6396	3.80591	6441	3.80895
6307	3.79982	6352	3.80291	6397	3.80598	6442	3.80902
6308	3.79989	6353	3.80298	6398	3.80604	6443	3.80909
6309	3.79996	6354	3.80305	6399	3.80611	6444	3.80916
6310	3.80003	6355	3.80312	6400	3.80618	6445	3.80922
6311	3.80010	6356	3.80318	6401	3.80625	6446	3.80929
6312	3.80017	6357	3.80325	6402	3.80632	6447	3.80936
6313	3.80024	6358	3.80332	6403	3.80638	6448	3.80943
6314	3.80030	6359	3.80339	6404	3.80645	6449	3.80949
6315	3.80037	6360	3.80346	6405	3.80652	6450	3.80956
6316	3.80044	6361	3.80353	6406	3.80659	6451	3.80963
6317	3.80051	6362	3.80359	6407	3.80665	6452	3.80969
6318	3.80058	6363	3.80366	6408	3.80672	6453	3.80976
6319	3.80065	6364	3.80373	6409	3.80679	6454	3.80983
6320	3.80072	6365	3.80380	6410	3.80686	6455	3.80990
6321	3.80079	6366	3.80387	6411	3.80693	6456	3.80996
6322	3.80085	6367	3.80393	6412	3.80699	6457	3.81003
6323	3.80092	6368	3.80400	6413	3.80706	6458	3.81010
6324	3.80099	6369	3.80407	2414	3.80713	6459	3.81017
6325	3.80106	6370	3.80414	6415	3.80720	6460	3.81023
6326	3.80113	6371	3.80421	6416	3.80726	6461	3.81030
6327	3.80120	6372	3.80428	6417	3.80733	6462	3.81037
6328	3.80127	6373	3.80434	6418	3.80740	6463	3.81043
6329	3.80134	6374	3.80441	6419	3.80747	6464	3.81050
6330	3.80140	6375	3.80448	6420	3.80754	6465	3.81057
6331	3.80147	6376	3.80455	6421	3.80760	6466	3.81064
6332	3.80154	6377	3.80462	6422	3.80767	6467	3.81070
6333	3.80161	6378	3.80468	6423	3.80774	6468	3.81077
6334	3.80168	6379	3.80475	6424	3.80781	6469	3.81084
6335	3.80175	6380	3.80482	6425	3.80787	6470	3.81090
6336	3.80182	6381	3.80489	6426	3.80794	6471	3.81097
6337	3.80188	6382	3.80496	6427	3.80801	6472	3.81104
6338	3.80195	6383	3.80502	6428	3.80808	6473	3.81111
6339	3.80202	6384	3.80509	6429	3.80814	6474	3.81117
6340	3.80209	6385	3.80516	6430	3.80821	6475	3.81[illegible]
6341	3.80216	6386	3.80523	6431	3.80828	6476	[illegible]
6342	3.80223	6387	3.80530	6432	3.80835	6477	3.81137
6343	3.80229	6388	3.80536	6433	3.80841	6478	3.81144
6344	3.80236	6389	3.80543	6434	3.80848	6479	3.811[illegible]
6345	3.80243	6390	3.80550	6435	3.80855	6480	3.811[illegible]

6481

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
6481	3.81164	6526	3.81465	6571	3.81763	6616	3.82060
6482	3.81171	6527	3.81471	6572	3.81770	6617	3.82066
6483	3.81178	6528	3.81478	6573	3.81776	6618	3.82073
6484	3.81184	6526	3.81485	6574	3.81783	6619	3.82079
6485	3.81191	6530	3.81491	6575	3.81790	6620	3.82086
6486	3.81198	6531	3.81498	6576	3.81796	6621	3.82092
6487	3.81204	6532	3.81505	6577	3.81803	6622	3.82099
6488	3.81211	6533	3.81511	6578	3.81809	6623	3.82105
6489	3.81218	6534	3.81518	6579	3.81816	6624	3.82112
6490	3.81224	6535	3.81525	6580	3.81823	6625	3.82119
6491	3.81231	6536	3.81531	6581	3.81829	6626	3.82125
6492	3.81238	6537	3.81538	6582	3.81836	6627	3.82132
6493	3.81245	6538	3.81544	6583	3.81842	6628	3.82138
6494	3.81251	6539	3.81551	6584	3.81849	6629	3.82145
6495	3.81258	6540	3.81558	6585	3.81856	6630	3.82151
6496	3.81265	6541	3.81564	6586	3.81862	6631	3.82158
6497	3.81271	6542	3.81571	6587	3.81869	6632	3.82164
6498	3.81278	6543	3.81578	6588	3.81875	6633	3.82171
6499	3.81285	6544	3.81584	6589	3.81882	6634	3.82178
6500	3.81291	6545	3.81591	6590	3.81889	6635	3.82184
6501	3.81298	6546	3.81598	6591	3.81895	6636	3.82191
6502	3.81305	6547	3.81604	6592	3.81902	6637	3.82197
6503	3.81311	6548	3.81611	6593	3.81908	6638	3.82204
6504	3.81318	6549	3.81618	6594	3.81915	6639	3.82210
6505	3.81325	6550	3.81624	6595	3.81921	6640	3.82217
6506	3.81331	6551	3.81631	6596	3.81928	6641	3.82223
6507	3.81338	6552	3.81637	6597	3.81935	6642	3.82230
6508	3.81345	6553	3.81644	6598	3.81941	6643	3.82236
6509	3.81351	6554	3.81651	6599	3.81948	6644	3.82243
6510	3.81358	6555	3.81657	6600	3.81954	6645	3.82250
6511	3.81365	6556	3.81664	6601	3.81961	6646	3.82256
6512	3.81371	6557	3.81671	6602	3.81968	6647	3.82263
6513	3.81378	6558	3.81677	6603	3.81974	6648	3.82269
6514	3.81385	6559	3.81684	6604	3.81981	6649	3.82276
6515	3.81391	6560	3.81690	6605	3.81987	6650	3.82282
6516	3.81398	6561	3.81697	6606	3.81994	6651	3.82289
6517	3.81405	6562	3.81704	6607	3.82000	6652	3.82295
6518	3.81411	6563	3.81710	6608	3.82007	6653	3.82302
6519	3.81418	6564	3.81717	6609	3.82014	6654	3.82308
6520	3.81425	6565	3.81723	6610	3.82020	6655	3.82315
6521	3.81431	6566	3.81730	6611	3.82027	6656	3.82321
6522	3.81438	6567	3.81737	6612	3.82033	6657	3.82328
6523	3.81445	6568	3.81743	6613	3.82040	6658	3.82334
6524	3.81451	6569	3.81750	6614	3.82046	6659	3.82341
6525	3.81458	6570	3.81757	6615	3.82053	6660	3.82347

N.	Logar.	N	Logar.	N.	Logar.	N.	Logar.
6661	3.82354	6706	3.82646	6751	3.82937	6796	83225
6662	3.82360	6707	3.82653	6752	3.82943	6797	3.83232
6663	3.82367	6708	3.82659	6753	3.82950	6798	3.83238
6664	3.82374	6709	3.82666	6754	3.82956	6799	3.83245
6665	3.82380	6710	3.82672	6755	3.82963	6800	3.83251
6666	3.82387	6711	3.82679	6756	3.82969	6801	3.83257
6667	3.82393	6712	3.82685	6757	3.82975	6802	3.83264
6668	3.82400	6713	3.82692	6758	3.82982	6803	3.83270
6669	3.82406	6714	3.82698	6759	3.82988	6804	3.83276
6670	3.82413	6715	3.82705	6760	3.82995	6805	3.83283
6671	3.82419	6716	3.82711	6761	3.83001	6806	3.83289
6672	3.82426	6717	3.82718	6762	3.83008	6807	3.83296
6673	3.82432	6718	3.82724	6763	3.83014	6808	3.83302
6674	3.82439	6719	3.82730	6764	3.83020	6809	3.83308
6675	3.82445	6720	3.82737	6765	3.83027	6810	3.83315
6676	3.82452	6721	3.82743	6766	3.83033	6811	3.83321
6677	3.82458	6722	3.82750	6767	3.83040	6812	3.83327
6678	3.82465	6723	3.82756	6768	3.83046	6813	3.83334
6679	3.82471	6724	3.82763	6769	3.83052	6814	3.83340
6680	3.82478	6725	3.82769	6770	3.83059	6815	3.83347
6681	3.82484	6726	3.82776	6771	3.83065	6816	3.33353
6682	3.82491	6727	3.82782	6772	3.83072	6817	3.83359
6683	3.82497	6728	3.82789	6773	3.83078	6818	3.83366
6684	3.82504	6729	3.82795	6774	3.83085	6819	3.83372
6685	3.82510	6730	3.82802	6775	3.83091	6820	3.83378
6686	3.82517	6731	3.82808	6776	3.83097	6821	3.83385
6687	3.82523	6732	3.82814	6777	3.83104	6822	3.83391
6688	3.82530	6733	3.82821	6778	3.83110	6823	3.83398
6689	3.82536	6734	3.82827	6779	3.83117	6824	3.83404
6690	3.82543	6735	3.82834	6780	3.83123	6825	3.83410
6691	3.82549	6736	3.82840	6781	3.83129	6826	3.83417
6692	3.82556	6737	3.82847	6782	3.83136	6827	3.83423
6693	3.82562	6738	3.82853	6783	3.83142	6828	3.83429
6694	3.82569	6739	3.82860	6784	3.83149	6829	3.83436
6695	3.82575	6740	3.82866	6785	3.83155	6830	3.83442
6696	3.82582	6741	3.82872	6786	3.83161	6831	3.83448
6697	3.82588	6742	3.82879	6787	3.83168	6832	3.83455
6698	3.82595	6743	3.82885	6788	3.83174	6833	3.83461
6699	3.82601	6744	3.82892	6789	3.83181	6834	3.83468
6700	3.82607	6745	3.82898	6790	3.83187	6835	3.83474
6701	3.82614	6746	3.82905	6791	3.83193	6836	3.83480
6702	3.82620	6747	3.82911	6792	3.83200	6837	3.83487
6703	3.82627	6748	3.82918	6793	3.83206	6838	3.83493
6704	3.82633	6749	3.82924	6794	3.83213	6839	3.83499
6705	3.82640	6750	3.82930	6795	3.83219	6840	3.83506

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
6841	3.83512	6886	3.83797	6931	3.84080	6976	3.84361
6842	3.83518	6887	3.83803	6932	3.84086	6977	3.84367
6843	3.83525	6888	3.83809	6933	3.84092	6978	3.84373
6844	3.83531	6889	3.83816	6934	3.84098	6979	3.84379
6845	3.83537	6890	3.83822	6935	3.84105	6980	3.84386
6846	3.83544	6891	3.83828	6936	3.84111	6981	3.84392
6847	3.83550	6892	3.83835	6937	3.84117	6982	3.84398
6848	3.83556	6893	3.83841	6938	3.84123	6983	3.84404
6849	3.83563	6894	3.83847	6939	3.84130	6984	3.84410
6850	3.83569	6895	3.83853	6940	3.84136	6985	3.84417
6851	3.83575	6896	3.83860	6941	3.84142	6986	3.84423
6852	3.83582	6897	3.83866	6942	3.84148	6987	3.84429
6853	3.83588	6898	3.83872	6943	3.84155	6988	3.84435
6854	3.83594	6899	3.83879	6944	3.84161	6989	3.84442
6855	3.83601	6900	3.83885	6945	3.84167	6990	3.84448
6856	3.83607	6901	3.83891	6946	3.84173	6991	3.84454
6857	3.83613	6902	3.83898	6947	3.84180	6992	3.84460
6858	3.83620	6903	3.83904	6948	3.84186	6993	3.84466
6859	3.83626	6904	3.83910	6949	3.84192	6994	3.84473
6860	3.83632	6905	3.83916	6950	3.84198	6995	3.84479
6861	3.83639	6906	3.83923	6951	3.84205	6996	3.84485
6862	3.83645	6907	3.83929	6952	3.84211	6997	3.84491
6863	3.83651	6908	3.83935	6953	3.84217	6998	3.84497
6864	3.83658	6909	3.83942	6954	3.84223	6999	3.84504
6865	3.83664	6910	3.83948	6955	3.84230	7000	3.84510
6866	3.83670	6911	3.83954	6956	3.84236	7001	3.84516
6867	3.83677	6912	3.83960	6957	3.84242	7002	3.84522
6868	3.83683	6913	3.83967	6958	3.84248	7003	3.84528
6869	3.83689	6914	3.83973	6959	3.84255	7004	3.84535
6870	3.83696	6915	3.83979	6960	3.84261	7005	3.84541
6871	3.83702	6916	3.83986	6961	3.84267	7006	3.84547
6872	3.83708	6917	3.83992	6962	3.84273	7007	3.84553
6873	3.83715	6918	3.83998	6963	3.84280	7008	3.84559
6874	3.83721	6919	3.84004	6964	3.84286	7009	3.84566
6875	3.83727	6920	3.84011	6965	3.84292	7010	3.84572
6876	3.83734	6921	3.84017	6966	3.84298	7011	3.84578
6877	3.83740	6922	3.84023	6967	3.84305	7012	3.84584
6878	3.83746	6923	3.84029	6968	3.84311	7013	3.84590
6879	3.83753	6924	3.84036	6969	3.84317	7014	3.84597
6880	3.83759	6925	3.84042	6970	3.84323	7015	3.84603
6881	3.83765	6926	3.84048	6971	3.84330	7016	3.84609
6882	3.83771	6927	3.84055	6972	3.84336	7017	3.84615
6883	3.83778	6928	3.84061	6973	3.84342	7018	3.84621
6884	3.83784	6929	3.84067	6974	3.84348	7019	3.84628
6885	3.83790	6930	3.84073	6975	3.84354	7020	3.84634

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
7021	3.84640	7066	3.84917	7111	3.85193	7156	3.85467
7022	3.84646	7067	3.84924	7112	3.85199	7157	3.85473
7023	3.84652	7068	3.84930	7113	3.85205	7158	3.85479
7024	3.84658	7069	3.84936	7114	3.85211	7159	3.85485
7025	3.84665	7070	3.84942	7115	3.85217	7160	3.85491
7026	3.84671	7071	3.84948	7116	3.85224	7161	3.85497
7027	3.84677	7072	3.84954	7117	3.85230	7162	3.85503
7028	3.84683	7073	3.84960	7118	3.85236	7163	3.85509
7029	3.84689	7074	3.84967	7119	3.85242	7164	3.85516
7030	3.84696	7075	3.84973	7120	3.85248	7165	3.85522
7031	3.84702	7076	3.84979	7121	3.85254	7166	3.85528
7032	3.84708	7077	3.84985	7122	3.85260	7167	3.85534
7033	3.84714	7078	3.84991	7123	3.85266	7168	3.85540
7034	3.84720	7079	3.84997	7124	3.85272	7169	3.85546
7035	3.84726	7080	3.85003	7125	3.85278	7170	3.85552
7036	3.84733	7081	3.85009	7126	3.85285	7171	3.85558
7037	3.84739	7082	3.85016	7127	3.85291	7172	3.85564
7038	3.84745	7083	3.85022	7128	3.85297	7173	3.85570
7039	3.84751	7084	3.85028	7129	3.85303	7174	3.85576
7040	3.84757	7085	3.85034	7130	3.85309	7175	3.85582
7041	3.84763	7086	3.85040	7131	3.85315	7176	3.85588
7042	3.84770	7087	3.85046	7132	3.85321	7177	3.85594
7043	3.84776	7088	3.85052	7133	3.85327	7178	3.85600
7044	3.84782	7089	3.85058	7134	3.85333	7179	3.85606
7045	3.84788	7090	3.85065	7135	3.85339	7180	3.85612
7046	3.84794	7091	3.85071	7136	3.85345	7181	3.85618
7047	3.84800	7092	3.85077	7137	3.85352	7182	3.85625
7048	3.84807	7093	3.85083	7138	3.85358	7183	3.85631
7049	3.84813	7094	3.85089	7139	3.85364	7184	3.85637
7050	3.84819	7095	3.85095	7140	3.85370	7185	3.85643
7051	3.84825	7096	3.85101	7141	3.85376	7186	3.85649
7052	3.84831	7097	3.85107	7142	3.85382	7187	3.85655
7053	3.84837	7098	3.85114	7143	3.85388	7188	3.85661
7054	3.84844	7099	3.85120	7144	3.85394	7189	3.85667
7055	3.84850	7100	3.85126	7145	3.85400	7190	3.85673
7056	3.84856	7101	3.85132	7146	3.85406	7191	3.85679
7057	3.84862	7102	3.85138	7147	3.85412	7192	3.85685
7058	3.84868	7103	3.85144	7148	3.85418	7193	3.85691
7059	3.84874	7104	3.85150	7149	3.85425	7194	3.85697
7060	3.84880	7105	3.85156	7150	3.85431	7195	3.85703
7061	3.84887	7106	3.85163	7151	3.85437	7196	3.85709
7062	3.84893	7107	3.85169	7152	3.85443	7197	3.85715
7063	3.84899	7108	3.85175	7153	3.85449	7198	3.85721
7064	3.84905	7109	3.85181	7154	3.85455	7199	3.85727
7065	3.84911	7110	3.85187	7155	3.85461	7200	3.85733

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
7201	3.85739	7246	3.86010	7291	3.86279	7336	3.86546
7202	3.85745	7247	3.86016	7292	3.86285	7337	3.86552
7203	3.85751	7248	3.86022	7293	3.86291	7338	3.86558
7204	3.85757	7249	3.86028	7294	3.86297	7339	3.86564
7205	3.85763	7250	3.86034	7295	3.86303	7340	3.86570
7206	3.85769	7251	3.86040	7296	3.86308	7341	3.86576
7207	3.85775	7252	3.86046	7297	3.86314	7342	3.86581
7208	3.85781	7253	3.86052	7298	3.86320	7343	3.86587
7209	3.85788	7254	3.86058	7299	3.86326	7344	3.86593
7210	3.85794	7255	3.86064	7300	3.86332	7345	3.86599
7211	3.85800	7256	3.86070	7301	3.86338	7346	3.86605
7212	3.85806	7257	3.86076	7302	3.86344	7347	3.86611
7213	3.85812	7258	3.86082	7303	3.86350	7348	3.86617
7214	3.85818	7259	3.86088	7304	3.86356	7349	3.86623
7215	3.85824	7260	3.86094	7305	3.86362	7350	3.86629
7216	3.85830	7261	3.86100	7306	3.86368	7351	3.86635
7217	3.85836	7262	3.86106	7307	3.86374	7352	3.86641
7218	3.85842	7263	3.86112	7308	3.86380	7353	3.86646
7219	3.85848	7264	3.86118	7309	3.86386	7354	3.86652
7220	3.85854	7265	3.86124	7310	3.86392	7355	3.86658
7221	3.85860	7266	3.86130	7311	3.86398	7356	3.86664
7222	3.85866	7267	3.86136	7312	3.86404	7357	3.86670
7223	3.85872	7268	3.86141	7313	3.86410	7358	3.86676
7224	3.85878	7269	3.86147	7314	3.86416	7359	3.86682
7225	3.85884	7270	3.86153	7315	3.86421	7360	3.86688
7226	3.85890	7271	3.86159	7316	3.86427	7361	3.86694
7227	3.85896	7272	3.86165	7317	3.86433	7362	3.86700
7228	3.85902	7273	3.86171	7318	3.86439	7363	3.86705
7229	3.85908	7274	3.86177	7319	3.86445	7364	3.86711
7230	3.85914	7275	3.86183	7320	3.86451	7365	3.86717
7231	3.85920	7276	3.86189	7321	3.86457	7366	3.86723
7232	3.85926	7277	3.86195	7322	3.86463	7367	3.86729
7233	3.85932	7278	3.86201	7323	3.86469	7368	3.86735
7234	3.85938	7279	3.86207	7324	3.86475	7369	3.86741
7235	3.85944	7280	3.86213	7325	3.86481	7370	3.86747
7236	3.85950	7281	3.86219	7326	3.86487	7371	3.86753
7237	3.85956	7282	3.86225	7327	3.86493	7372	3.86759
7238	3.85962	7283	3.86231	7328	3.86499	7373	3.86764
7239	3.85968	7284	3.86237	7329	3.86504	7374	3.86770
7240	3.85974	7285	3.86243	7330	3.86510	7375	3.86776
7241	3.85980	7286	3.86249	7331	3.86516	7376	3.86782
7242	3.85986	7287	3.86255	7332	3.86522	7377	3.86788
7243	3.85992	7288	3.86261	7333	3.86528	7378	3.86794
7244	3.85998	7289	3.86267	7334	3.86534	7379	3.86800
7245	3.86004	7290	3.86273	7335	3.86540	7380	3.86806

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
7381	3.86812	7426	3.87075	7471	3.87338	7516	3.87599
7382	3.86817	7427	3.87081	7472	3.87344	7517	3.87604
7383	3.86823	7428	3.87087	7473	3.87350	7518	3.87610
7384	3.86829	7429	3.87093	7474	3.87355	7519	3.87616
7385	3.86835	7430	3.87099	7475	3.87361	7520	3.87622
7386	3.86841	7431	3.87105	7476	3.87367	7521	3.87628
7387	3.86847	7432	3.87111	7477	3.87373	7522	3.87633
7388	3.86853	7433	3.87116	7478	3.87379	7523	3.87639
7389	3.86859	7434	3.87122	7479	3.87384	7524	3.87645
7390	3.86864	7435	3.87128	7480	3.87390	7525	3.87651
7391	3.86870	7436	3.87134	7481	3.87396	7526	3.87656
7392	3.86876	7437	3.87140	7482	3.87402	7527	3.87662
7393	3.86882	7438	3.87146	7483	3.87408	7528	3.87668
7394	3.86888	7439	3.87151	7484	3.87413	7529	3.87674
7395	3.86894	7440	3.87157	7485	3.87419	7530	3.87680
7396	3.86900	7441	3.87163	7486	3.87425	7531	3.87685
7397	3.86906	7442	3.87169	7487	3.87431	7532	3.87691
7398	3.86911	7443	3.87175	7488	3.87437	7533	3.87697
7399	3.86917	7444	3.87181	7489	3.87442	7534	3.87703
7400	3.86923	7445	3.87186	7490	3.87448	7535	3.87708
7401	3.86929	7446	3.87192	7491	3.87454	7536	3.87714
7402	3.86935	7447	3.87198	7492	3.87460	7537	3.87720
7403	3.86941	7448	3.87204	7493	3.87466	7538	3.87726
7404	3.86947	7449	3.87210	7494	3.87471	7539	3.87731
7405	3.86953	7450	3.87216	7495	3.87477	7540	3.87737
7406	3.86958	7451	3.87221	7496	3.87483	7541	3.87743
7407	3.86964	7452	3.87227	7497	3.87489	7542	3.87749
7408	3.86970	7453	3.87233	7498	3.87495	7543	3.87754
7409	3.86976	7454	3.87239	7499	3.87500	7544	3.87760
7410	3.86982	7455	3.87245	7500	3.87506	7545	3.87766
7411	3.86988	7456	3.87251	7501	3.87512	7546	3.87772
7412	3.86994	7457	3.87256	7502	3.87518	7547	3.87777
7413	3.86999	7458	3.87262	7503	3.87523	7548	3.87783
7414	3.87005	7459	3.87268	7504	3.87529	7549	3.87789
7415	3.87011	7460	3.87274	7505	3.87535	7550	3.87795
7416	3.87017	7461	3.87280	7506	3.87541	7551	3.87800
7417	3.87023	7462	3.87286	7507	3.87547	7552	3.87806
7418	3.87029	7463	3.87291	7508	3.87552	7553	3.87812
7419	3.87035	7464	3.87297	7509	3.87558	7554	3.87818
7420	3.87040	7465	3.87303	7510	3.87564	7555	3.87823
7421	3.87046	7466	3.87309	7511	3.87570	7556	3.87829
7422	3.87052	7467	3.87315	7512	3.87576	7557	3.87835
7423	3.87058	7468	3.87320	7513	3.87581	7558	3.87841
7424	3.87064	7469	3.87326	7514	3.87587	7559	3.87846
7425	3.87070	7470	3.87332	7515	3.87593	7560	3.87852

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
7561	3.87858	7606	3.88116	7651	3.88372	7696	3.88627
7562	3.87864	7607	3.88121	7652	3.88378	7697	3.88632
7563	3.87869	7608	3.88127	7653	3.88383	7698	3.88638
7564	3.87875	7609	3.88133	7654	3.88389	7699	3.88643
7565	3.87881	7610	3.88138	7655	3.88395	7700	3.88649
7566	3.87887	7611	3.88144	7656	3.88400	7701	3.88655
7567	3.87892	7612	3.88150	7657	3.88406	7702	3.88660
7568	3.87898	7613	3.88156	7658	3.88412	7703	3.88666
7569	3.87904	7614	3.88161	7659	3.88417	7704	3.88672
7570	3.87910	7615	3.88167	7660	3.88423	7705	3.88677
7571	3.87915	7616	3.88173	7661	3.88429	7706	3.88683
7572	3.87921	7617	3.88178	7662	3.88434	7707	3.88689
7573	3.87927	7618	3.88184	7663	3.88440	7708	3.88694
7574	3.87933	7619	3.88190	7664	3.88446	7709	3.88700
7575	3.87938	7620	3.88196	7665	3.88451	7710	3.88705
7576	3.87944	7621	3.88201	7666	3.88457	7711	3.88711
7577	3.87950	7622	3.88207	7667	3.88463	7712	3.88717
7578	3.87955	7623	3.88213	7668	3.88468	7713	3.88722
7579	3.87961	7624	3.88218	7669	3.88474	7714	3.88728
7580	3.87967	7625	3.88224	7670	3.88480	7715	3.88734
7581	3.87973	7626	3.88230	7671	3.88485	7716	3.88739
7582	3.87978	7627	3.88235	7672	3.88491	7717	3.88745
7583	3.87984	7628	3.88241	7673	3.88497	7718	3.88750
7584	3.87990	7629	3.88247	7674	3.88502	7719	3.88756
7585	3.87996	7630	3.88252	7675	3.88508	7720	3.88762
7586	3.88001	7631	3.88258	7676	3.88514	7721	3.88767
7587	3.88007	7632	3.88264	7677	3.88519	7722	3.88773
7588	3.88013	7633	3.88270	7678	3.88525	7723	3.88779
7589	3.88018	7634	3.88275	7679	3.88530	7724	3.88784
7590	3.88024	7635	3.88281	7680	3.88536	7725	3.88790
7591	3.88030	7636	3.88287	7681	3.88542	7726	3.88795
7592	3.88036	7637	3.88292	7682	3.88547	7727	3.88801
7593	3.88041	7638	3.88298	7683	3.88553	7728	3.88807
7594	3.88047	7639	3.88304	7684	3.88559	7729	3.88812
7595	3.88053	7640	3.88309	7685	3.88564	7730	3.88818
7596	3.88059	7641	3.88315	7686	3.88570	7731	3.88824
7597	3.88064	7642	3.88321	7687	3.88576	7732	3.88829
7598	3.88070	7643	3.88326	7688	3.88581	7733	3.88835
7599	3.88076	7644	3.88332	7689	3.88587	7734	3.88840
7600	3.88081	7645	3.88338	7690	3.88593	7735	3.88846
7601	3.88087	7646	3.88343	7691	3.88598	7736	3.88852
7602	3.88093	7647	3.88349	7692	3.88604	7737	3.88857
7603	3.88099	7648	3.88355	7693	3.88610	7738	3.88863
7604	3.88104	7649	3.88360	7694	3.88615	7739	3.88868
7605	3.88110	7650	3.88366	7695	3.88621	7740	3.88874

N.	Logar.	N	Logar.	N	Logar.	N.	Logar.
7921	3.89878	7966	3.90124	8011	3.90369	8056	3.90612
7922	3.89883	7967	3.90129	8012	3.90374	8057	3.90617
7923	3.89889	7968	3.90135	8013	3.90380	8058	3.90623
7924	3.89894	7969	3.90140	8014	3.90385	8059	3.90628
7925	3.89900	7970	3.90146	8015	3.90390	8060	3.90634
7926	3.89905	7971	3.90151	8016	3.90396	8061	3.90639
7927	3.89911	7972	3.90157	8017	3.90401	8062	3.90644
7928	3.89916	7973	3.90162	8018	3.90407	8063	3.90650
7929	3.89922	7974	3.90168	8019	3.90412	8064	3.90655
7930	3.89927	7975	3.90173	8020	3.90417	8065	3.90660
7931	3.89933	7976	3.90179	8021	3.90423	8066	3.90666
7932	3.89938	7977	3.90184	8022	3.90428	8067	3.90671
7933	3.89944	7978	3.90189	8023	3.90434	8068	3.90677
7934	3.89949	7979	3.90195	8024	3.90439	8069	3.90682
7935	3.89955	7980	3.90200	8025	3.90445	8070	3.90687
7936	3.89960	7981	3.90206	8026	3.90450	8071	3.90693
7937	3.89966	7982	3.90211	8027	3.90455	8072	3.90698
7938	3.89971	7983	3.90217	8028	3.90461	8073	3.90704
7939	3.89977	7984	3.90222	8029	3.90466	8074	3.90709
7940	3.89982	7985	3.90227	8030	3.90472	8075	3.90714
7941	3.89988	7[illegible]	[illegible]3	8031	3.90477	8076	3.90720
7942	3.89993	7[illegible]	[illegible]8	8032	3.90482	8077	3.90725
7943	3.89998	7[illegible]	[illegible]4	8033	3.90488	8078	3.90730
7944	3.90004	7[illegible]	[illegible]49	8034	3.90493	8079	3.90736
7945	3.90009	7[illegible]	[illegible]55	8035	3.90499	8080	3.90741
7946	3.90015	7[illegible]	[illegible]60	8036	3.90504	8081	3.90747
7947	3.90020	7[illegible]	[illegible]66	8037	3.90509	8082	3.90752
7948	3.90026	7[illegible]	[illegible]71	8038	3.90515	8083	3.90757
7949	3.90031	7994	3.90276	8039	3.90520	8084	3.90763
7950	3.90037	7995	3.90282	8040	3.90526	8085	3.90768
7951	3.90042	7996	3.90287	8041	3.90531	8086	3.90773
7952	3.90048	7997	3.90293	8042	3.90536	8087	3.90779
7953	3.90053	7998	3.90298	8043	3.90542	8088	3.90784
7954	3.90059	7999	3.90304	8044	3.90547	8089	3.90789
7955	3.90064	8000	3.90309	8045	3.90553	8090	3.90795
7956	3.90069	8001	3.90314	8046	3.90558	8091	3.90800
7957	3.90075	8002	3.90320	8047	3.90563	8092	3.90806
7958	3.90080	8003	3.90325	8048	3.90569	8093	3.90811
7959	3.90086	8004	3.90331	8049	3.90574	8094	3.90816
7960	3.90091	8005	3.90336	8050	3.90580	8095	3.90822
7961	3.90097	8006	3.90342	8051	3.90585	8096	3.90827
7962	3.90102	8007	3.90347	8052	3.90590	8097	3.90832
7963	3.90108	8008	3.90352	8053	3.90596	8098	3.90838
7964	3.90113	8009	3.90358	8054	3.90601	8099	3.90843
7965	3.90119	8010	3.90363	8055	3.90607	8100	3.90849

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
8101	3.90854	8146	3.91094	8191	3.91334	8236	3.91572
8102	3.90859	8147	3.91100	8192	3.91339	8237	3.91577
8103	3.90865	8148	3.91105	8193	3.91344	8238	3.91582
8104	3.90870	8149	3.91110	8194	3.91350	8239	3.91587
8105	3.90875	8150	3.91116	8195	3.91355	8240	3.91593
8106	3.90881	8151	3.91121	8196	3.91360	8241	3.91598
8107	3.90886	8152	3.91126	8197	3.91365	8242	3.91603
8108	3.90891	8153	3.91132	8198	3.91371	8243	3.91609
8109	3.90897	8154	3.91137	8199	3.91376	8244	3.91614
8110	3.90902	8155	3.91142	8200	3.91381	8245	3.91619
8111	3.90907	8156	3.91148	8201	3.91387	8246	3.91624
8112	3.90913	8157	3.91153	8202	3.91392	8247	3.91630
8113	3.90918	8158	3.91158	8203	3.91397	8248	3.91635
8114	3.90924	8159	3.91164	8204	3.91403	8249	3.91640
8115	3.90929	8160	3.91169	8205	3.91408	8250	3.91645
8116	3.90934	8161	3.91174	8206	3.91413	8251	3.91651
8117	3.90940	8162	3.91180	8207	3.91418	8252	3.91656
8118	3.90945	8163	3.91185	8208	3.91424	8253	3.91661
8119	3.90950	8164	3.91190	8209	3.91429	8254	3.91666
8120	3.90956	8165	3.91196	8210	3.91434	8255	3.91672
8121	3.90961	8166	3.91201	8211	3.91440	8256	3.91677
8122	3.90966	8167	3.91206	8212	3.91445	8257	3.91682
8123	3.90972	8168	3.91212	8213	3.91450	8258	3.91687
8124	3.90977	8169	3.91217	8214	3.91455	8259	3.91693
8125	3.90982	8170	3.91222	8215	3.91461	8260	3.91698
8126	3.90988	8171	3.91228	8216	3.91466	8261	3.91703
8127	3.90993	8172	3.91232	8217	3.91471	8262	3.91709
8128	3.90998	8173	3.91238	8218	3.91477	8263	3.91714
8129	3.91004	8174	3.91243	8219	3.91482	8264	3.91719
8130	3.91009	8175	3.91249	8220	3.91487	8265	3.91724
8131	3.91014	8176	3.91254	8221	3.91492	8266	3.91730
8132	3.91020	8177	3.91259	8222	3.91498	8267	3.91735
8133	3.91025	8178	3.91265	8223	3.91503	8268	3.91740
8134	3.91030	8179	3.91270	8224	3.91508	8269	3.91745
8135	3.91036	8180	3.91275	8225	3.91514	8270	3.91751
8136	3.91041	8181	3.91281	8226	3.91519	8271	3.91756
8137	3.91046	8182	3.91286	8227	3.91524	8272	3.91761
8138	3.91052	8183	3.91291	8228	3.91529	8273	3.91766
8139	3.91057	8184	3.91297	8229	3.91535	8274	3.91772
8140	3.91062	8185	3.91302	8230	3.91540	8275	3.91777
8141	3.9100	8186	3.91307	8231	3.91545	8276	3.91782
8142	3.91073	8187	3.91312	8232	3.91551	8277	3.91787
8143	3.91078	8188	3.91318	8233	3.91556	8278	3.91793
8144	3.91084	8189	3.91323	8234	3.91561	8279	3.91798
8145	3.91089	8190	3.91328	8235	3.91566	8280	3.91803

8281

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
8821	3.94552	8866	3.94773	8911	3.94993	8956	3.95211
8822	3.94557	8867	3.94778	8912	3.94998	8957	3.95216
8823	3.94562	8868	3.94783	8913	3.95002	8958	3.95221
8824	3.94567	8869	3.94787	8914	3.95007	8959	3.95226
8825	3.94671	8870	3.94792	8915	3.95012	8960	3.95231
8826	3.94576	8871	3.94797	8916	3.95017	8961	3.95236
8827	3.94581	8872	3.94802	8917	3.95022	8962	3.95240
8828	3.94586	8873	3.94807	8918	3.95027	8963	3.95245
8829	3.94591	8874	3.94812	8919	3.95032	8964	3.95250
8830	3.94596	8875	3.54817	8920	3.95036	8965	3.95255
8831	3.94601	8876	3.94822	8921	3.95041	8966	3.95260
8832	3.94606	8877	3.94827	8922	3.95046	8967	3.95265
8833	3.94611	8878	3.94832	8923	3.95051	8968	3.95270
8834	3.94616	8879	3.94836	8924	3.95056	8969	3.95274
8835	3.94621	8880	3.94841	8925	3.95061	8970	3.95279
8836	3.94626	8881	3.94846	8926	3.95066	8971	3.95284
8837	3.94630	8882	3.94851	8927	3.95071	8972	3.95289
8838	3.94635	8883	3.94856	8928	3.95075	8973	3.95294
8839	3.94640	8884	3.94861	8929	3.95080	8974	3.95299
8840	3.94645	8885	3.94866	8930	3.95085	8975	3.95303
8841	3.94650	8886	3.94871	8931	3.95090	8976	3.95308
8842	3.94655	8887	3.94876	8932	3.95095	8977	3.95313
8843	3.94660	8888	3.94880	8933	3.95100	8978	3.95318
8844	3.94665	8889	3.94885	8934	3.95105	8979	3.95323
8845	3.94670	8890	3.94890	8935	3.95109	8980	3.95328
8846	3.94675	8891	3.94895	8936	3.95114	8981	3.95332
8847	3.94680	8892	3.94900	8937	3.95119	8982	3.95337
8848	3.94685	8893	3.94905	8938	3.95124	8983	3.95342
8849	3.94689	8894	3.94910	8939	3.95129	8984	3.95347
8850	3.94694	8895	3.94915	8940	3.95134	8985	3.95352
8851	3.94699	8896	3.94919	8941	3.95139	8986	3.95357
8852	3.94704	8897	3.94924	8942	3.95143	8987	3.95361
8853	3.94709	8898	3.94929	8943	3.95148	8988	3.95366
8854	3.94714	8899	3.94934	8944	3.95153	8989	3.95371
8855	3.94719	8900	3.94939	8945	3.95158	8990	3.95376
8856	3.94724	8901	3.94944	8946	3.95163	8991	3.95381
8857	3.94729	8902	3.94949	8947	3.95168	8992	3.95386
8858	3.94734	8903	3.94954	8948	3.95173	8993	3.95390
8859	3.94738	8904	3.94959	8949	3.95177	8994	3.95395
8860	3.94743	8905	3.94963	8950	3.95182	8995	3.95400
8861	3.94748	8906	3.94968	8951	3.95187	8996	3.95405
8862	3.94753	8907	3.94973	8952	3.95192	8997	3.95410
8863	3.94758	8908	3.94978	8953	3.95197	8998	3.95415
8864	3.94763	8909	3.94983	8954	3.95202	8999	3.95419
8865	3.94768	8910	3.94988	8955	3.95207	9000	3.95424

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
9181	3.96289	9226	3.96501	9271	3.96713	9316	3.96923
9182	3.96294	9227	3.96506	9272	3.96717	9317	3.96928
9183	3.96298	9228	3.96511	9273	3.96722	9318	3.96932
9184	3.96303	9229	3.96515	9274	3.96727	9319	3.96937
9185	3.96308	9230	3.96520	9275	3.96731	9320	3.96942
9186	3.96313	9231	3.96525	9276	3.96736	9321	3.96946
9187	3.96317	9232	3.96530	9277	3.96741	9322	3.96951
9188	3.96322	9233	3.96534	9278	3.96745	9323	3.96956
9189	3.96327	9234	3.96539	9279	3.96750	9324	3.96960
9190	3.96332	9235	3.96544	9280	3.96755	9325	3.96965
9191	3.96336	9236	3.96548	9281	3.96759	9326	3.96970
9192	3.96341	9237	3.96553	9282	3.96764	9327	3.96974
9193	3.96346	9238	3.96558	9283	3.96769	9328	3.96979
9194	3.96350	9239	3.96563	9284	3.96774	9329	3.96984
9195	3.96355	9240	3.96567	9285	3.96778	9330	3.96988
9196	3.96360	9241	3.96572	9286	3.96783	9331	3.96993
9197	3.96365	9242	3.96577	9287	3.96788	9332	3.96997
9198	3.96369	9243	3.96581	9288	3.96792	9333	3.97002
9199	3.96374	9244	3.96586	9289	3.96797	9334	3.97007
9200	3.96379	9245	3.96591	9290	3.96802	9335	3.97011
9201	3.96384	9246	3.96595	9291	3.96806	9336	3.97016
9202	3.96388	9247	3.96600	9292	3.96811	9337	3.97021
9203	3.96393	9248	3.96605	9293	3.96816	9338	3.97025
9204	3.96398	9249	3.96609	9294	3.96820	9339	3.97030
9205	3.96402	9250	3.96614	9295	3.96825	9340	3.97035
9206	3.96407	9251	3.96619	9296	3.96830	9341	3.97039
9207	3.96412	9252	3.96624	9297	3.96834	9342	3.97044
9208	3.96417	9253	3.96628	9298	3.96839	9343	3.97049
9209	3.96421	9254	3.96633	9299	3.96844	9344	3.97053
9210	3.96426	9255	3.96638	9300	3.96848	9345	3.97058
9211	3.96431	9256	3.96642	9301	3.96853	9346	3.97063
9212	3.96435	9257	3.96647	9302	3.96858	9347	3.97067
9213	3.96440	9258	3.96652	9303	3.96862	9348	3.97072
9214	3.96445	9259	3.96656	9304	3.96867	9349	3.97077
9215	3.96450	9260	3.96661	9305	3.96872	9350	3.97081
9216	3.96454	9261	3.96666	9306	3.96876	9351	3.97086
9217	3.96459	9262	3.9[illegible]0	9307	3.96881	9352	3.97090
9218	3.96464	9263	3.9[illegible]5	9308	3.96886	9353	3.97095
9219	3.96468	9264	3.9[illegible]0	9309	3.96890	9354	3.97100
9220	3.96473	9265	3.9[illegible]5	9310	3.96895	9355	3.97104
9221	3.96478	9266	3.9[illegible]9	9311	3.96900	9356	3.97109
9222	3.96483	9267	3.9[illegible]4	9312	3.96904	9357	3.97114
9223	3.96487	9268	3.96699	9313	3.96909	9358	3.97118
9224	3.96492	9269	3.96703	9314	3.96914	9359	3.97123
9225	3.96497	9270	3.96708	9315	3.96918	9360	3.97128

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
9361	3.97132	9406	3.97341	9451	3.97548	9496	3.97754
9362	3.97137	9407	3.97345	9452	3.97552	9497	3.97759
9363	3.97142	9408	3.97350	9453	3.97557	9498	3.97763
9364	3.97146	9409	3.97354	9454	3.97562	9499	3.97768
9365	3.97151	9410	3.97359	9455	3.97566	9500	3.97772
9366	3.97155	9411	3.97364	9456	3.97571	9501	3.97777
9367	3.97160	9412	3.97368	9457	3.97575	9502	3.97782
9368	3.97165	9413	3.97373	9458	3.97580	9503	3.97786
9369	3.97169	9414	3.97377	9459	3.97585	9504	3.97791
9370	3.97174	9415	3.97382	9460	3.97589	9505	3.97795
9371	3.97179	9416	3.97387	9461	3.97594	9506	3.97800
9372	3.97183	9417	3.97391	9462	3.97598	9507	3.97804
9373	3.97188	9418	3.97396	9463	3.98603	9508	3.97809
9374	3.97192	9419	3.97400	9464	3.97607	9509	3.97813
9375	3.97197	9420	3.97405	9465	3.97612	9510	3.97818
9376	3.97202	9421	3.97410	9466	3.97617	9511	3.97823
9377	3.97206	9422	3.97414	9467	3.97621	9512	3.97827
9378	3.97211	9423	3.97419	9468	3.97626	9513	3.97832
9379	3.97216	9424	3.97424	9469	3.97630	9514	3.97836
9380	3.97229	9425	3.97428	9470	3.97635	9515	3.97841
9381	3.97225	9426	3.97433	9471	3.97640	9516	3.97845
9382	3.97230	9427	3.97437	9472	3.97644	9517	3.97850
9383	3.97234	9428	3.97442	9473	3.97649	9518	3.97855
9384	3.97239	9429	3.97447	9474	3.97653	9519	3.97859
9385	3.97243	9430	3.97451	9475	3.97658	9520	3.97864
9336	3.97248	9431	3.97456	9476	3.97663	9521	3.97868
9387	3.97253	9432	3.97460	9477	3.97667	9522	3.97873
9388	3.97257	9433	3.97465	9478	3.97672	9523	3.97877
9389	3.97262	9434	3.97470	9479	3.97676	9524	3.97882
9390	3.97267	9435	3.97474	9480	3.97681	9525	3.97887
9391	3.97271	9436	3.97479	9481	3.97685	9526	3.97891
9392	3.97276	9437	3.97483	9482	3.97690	9527	3.97896
9393	3.97280	9438	3.97488	9483	3.97695	9528	3.97900
9394	3.97285	9439	3.97493	9484	3.97699	9529	3.97905
9395	3.97290	9440	3.97497	9485	3.97704	9530	3.97909
9396	3.97294	9441	3.97502	9486	3.97708	9531	3.97914
9397	3.97299	9442	3.97506	9487	3.97713	9532	3.97918
9398	3.97304	9443	3.97511	9488	3.97717	9533	3.97923
9399	3.97308	9444	3.97516	9489	3.97722	9534	3.97928
9400	3.97313	9445	3.97520	9490	3.97727	9535	3.97932
9401	3.97317	9446	3.97525	9491	3.97731	9536	3.97937
9402	3.97322	9447	3.97529	9492	3.97736	9537	3.97941
9403	3.97327	9448	3.97534	9493	3.97740	9538	3.97946
9404	3.97331	9449	3.97539	9494	3.97745	9539	3.97950
9405	3.97336	9450	3.97543	9495	3.97750	9540	3.97955

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
9721	3.98771	9766	3.98972	9811	3.99171	9856	3.99370
9722	3.98776	9767	3.98976	9812	3.99176	9857	3.99374
9723	3.98780	9768	3.98981	9813	3.99180	9858	3.99379
9724	3.98784	9769	3.98985	9814	3.99185	9859	3.99383
9725	3.98789	9770	3.98989	9815	3.99189	9860	3.99388
9726	3.98793	9771	3.98994	9816	3.99193	9861	3.99392
9727	3.98798	9772	3.98998	9817	3.99198	9862	3.99397
9728	3.98802	9773	3.99003	9818	3.99202	9863	3.99401
9729	3.98807	9774	3.99007	9819	3.99207	9864	3.99405
9730	3.98811	9775	3.99012	9820	3.99211	9865	3.99410
9731	3.98816	9776	3.99016	9821	3.99216	9866	3.99414
9732	3.98820	9977	3.99021	9822	3.99220	9867	3.99419
9733	3.98825	9778	3.99025	9823	3.99224	9868	3.99423
9734	3.98829	9779	3.99029	9824	3.99229	9869	3.99427
9735	3.98834	9780	3.99034	9825	3.99233	9870	3.99432
9736	3.98838	9781	3.99038	9826	3.99238	9871	3.99436
9737	3.98843	9782	3.99043	9827	3.99242	9872	3.99441
9738	3.98847	9783	3.99047	9828	3.99247	9873	3.99445
9739	3.98851	9784	3.99052	9829	3.99251	9874	3.99449
9740	3.98856	9785	3.99056	9830	3.99255	9875	3.99454
9741	3.98860	9786	3.99061	9831	3.99260	9876	3.99458
9242	3.98865	9787	3.99065	9832	3.99264	9877	3.99463
9743	3.98869	9788	3.99069	9833	3.99269	9878	3.99467
9744	3.98874	9789	3.99074	9834	3.99273	9879	3.99471
9745	3.98878	9790	3.99078	9835	3.99277	9880	3.99476
9746	3.98883	9791	3.99083	9836	3.99282	9881	3.99480
9747	3.98887	9792	3.99087	9837	3.99286	9882	3.99484
9748	3.98892	9793	3.99092	9838	3.99291	9883	3.99489
9749	3.98896	9794	3.99096	9839	3.99295	9884	3.99493
9750	3.98900	9795	3.99100	9340	3.99300	9885	3.99498
9751	3.98905	9796	3.99105	9841	3.99304	9886	3.99502
9752	3.98909	9797	3.99109	9842	3.99308	9887	3.99506
9753	3.98914	9798	3.99114	9843	3.99313	9888	3.99511
9754	3.98918	9799	3.99118	9844	3.99317	9889	3.99515
9755	3.98922	9800	3.99123	9845	3.99322	9890	3.99520
9756	3.98927	9801	3.99127	9846	3.99326	9891	3.99524
9757	3.98932	9802	3.99131	9847	3.99330	9892	3.99528
9758	3.98936	9803	3.99136	9848	3.99335	9893	3.99533
9759	3.98941	9804	3.99140	9849	3.99339	9894	3.69537
9760	3.98945	9805	3.99145	9850	3.99344	9895	3.99542
9761	3.98949	9806	3.99149	9851	3.99348	9896	3.99546
9762	3.98954	9807	3.99154	9852	3.99352	9897	3.99550
9763	3.98958	9808	3.99158	9853	3.99357	9898	3.99555
9764	3.98963	9809	3.99162	9854	3.99361	9899	3.99559
9765	3.98967	9810	3.99167	9855	3.99366	9900	3.99564

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h A TABLE

A
TABLE
OF
Artificial SINES, TANGENTS and SECANTS, the Radius 10.00000; and to every Degree and Minute of the QUADRANT.

A Table of Artificial Sines,

1 Degree,

Min.	Sine.		Tang.		Secant.		
0	8.24186	9.99993	8.24192	11.75808	10.00007	11.75815	60
1	8.24903	9.99993	8.24910	11.75090	10.00007	11.75098	59
2	8.25609	9.99993	8.25617	11.74384	10.00007	11.74391	58
3	8.26304	9.99993	8.26312	11.73689	10.00007	11.73096	57
4	8.26988	9.99993	8.26996	11.73004	10.00007	11.73012	56
5	8.27661	9.99992	8.27669	11.72331	10.00008	11.72339	55
6	8.28324	9.99992	8.28332	11.71668	10.00008	11.71676	54
7	8.28977	9.99992	8.28986	11.71014	10.00008	11.71023	53
8	8.29621	9.99992	8.29629	11.70371	10.00009	11.70379	52
9	8.30255	9.99991	8.30263	11.69737	10.00009	11.69745	51
10	8.30879	9.99991	8.30888	11.69112	10.00009	11.69121	50
11	8.31495	9.99991	8.31505	11.68495	10.00009	11.68505	49
12	8.32103	9.99991	8.32112	11.67888	10.00010	11.67897	48
13	8.32702	9.99990	8.32711	11.67289	10.00010	11.67298	47
14	8.33292	9.99990	8.33303	11.66698	10.00010	11.66708	46
15	8.33875	9.99990	8.33886	11.66114	10.00010	11.66125	45
16	8.34450	9.99989	8.34461	11.65539	10.00011	11.65550	44
17	8.35018	9.99989	8.35029	11.64971	10.00011	11.64982	43
18	8.35578	9.99989	8.35590	11.64411	10.00011	11.64422	42
19	8.36132	9.99989	8.36143	11.63857	10.00012	11.63869	41
20	8.36678	9.99988	8.36689	11.63311	10.00012	11.63322	40
21	8.37217	9.99988	8.37229	11.62771	10.00012	11.62783	39
22	8.37750	9.99988	8.37762	11.62238	10.00012	11.62250	38
23	8.38276	9.99987	8.38289	11.61711	10.00013	11.61724	37
24	8.38796	9.99987	8.38809	11.61191	10.00013	11.61204	36
25	8.39310	9.99987	8.39323	11.60677	10.00013	11.60690	35
26	8.39818	9.99986	8.39832	11.60169	10.00014	11.60182	34
27	8.40320	9.99986	8.40334	11.59666	10.00014	11.59680	33
28	8.40816	9.99986	8.40830	11.59170	10.00014	11.59184	32
29	8.41307	9.99985	8.41321	11.58679	10.00015	11.58693	31
30	8.41792	9.99985	8.41807	11.58193	10.00015	11.58208	30
		Sine.		Tang.		Secant	Min.

88 Degrees.

Tangents and Secants.

1 *Degree.*

Min.	Sine.		Tang.		Secant.		
30	8.41792	9.99985	8.41807	11.58193	10.00015	11.58208	30
31	8.42272	9.99985	8.42287	11.57713	10.00015	11.57728	29
32	8.42746	9.99984	8.42762	11.57238	10.00016	11.57254	28
33	8.43216	9.99984	8.43232	11.56769	10.00016	11.56784	27
34	8.43680	9.99984	8.43696	11.56304	10.00016	11.56320	26
35	8.44139	9.99983	8.44156	11.55844	10.00017	11.55861	25
36	8.44594	9.99983	8.44611	11.55389	10.00017	11.55406	24
37	8.45044	9.99983	8.45061	11.54939	10.00017	11.54956	23
38	8.45489	9.99982	8.45507	11.54493	10.00018	11.54511	22
39	8.45930	9.99982	8.45948	11.54052	10.00018	11.54070	21
40	8.46366	9.99982	8.46385	11.53615	10.00018	11.53634	20
41	8.46799	9.99981	8.46817	11.53183	10.00019	11.53202	19
42	8.47226	9.99981	8.47245	11.52755	10.00019	11.52774	18
43	8.47650	9.99981	8.47669	11.52331	10.00020	11.52350	17
44	8.48069	9.99980	8.48089	11.51911	10.00020	11.51931	16
45	8.48485	9.99980	8.48505	11.51495	10.00020	11.51515	15
46	8.48896	9.99979	8.48917	11.51083	10.00021	11.51104	14
47	8.49304	9.99979	8.49325	11.50675	10.00021	11.50696	13
48	8.49708	9.99979	8.49729	11.50271	10.00021	11.50292	12
49	8.50108	9.99978	8.50130	11.49870	10.00022	11.49892	11
50	8.50505	9.99978	8.50527	11.49473	10.00022	11.49496	10
51	8.50897	9.99977	8.50920	11.49080	10.00023	11.49103	9
52	8.51287	9.99977	8.51310	11.48690	10.00023	11.48713	8
53	8.51673	9.99977	8.51696	11.48304	10.00024	11.48327	7
54	8.52055	9.99976	8.52079	11.47921	10.00024	11.47945	6
55	8.52434	9.99976	8.52459	11.47541	10.00024	11.47566	5
56	8.52810	9.99975	8.52835	11.47165	10.00025	11.47190	4
57	8.53183	9.99975	8.53208	11.46792	10.00025	11.46817	3
58	8.53552	9.99974	8.53578	11.46422	10.00026	11.46448	2
59	8.53919	9.99974	8.53945	11.46055	10.00026	11.46081	1
60	8.54282	9.99974	8.54308	11.45692	10.00027	11.45718	0
		Sine.		Tang.		Secant.	Min.

88 *Degrees.*

A Table of Artificial Sines,

1 *Degree*,

Min.	Sine.		Tang.		Secant.		
0	8.24186	9.99993	8.24192	11.75808	10.00007	11.75815	60
1	8.24903	9.99993	8.24910	11.75090	10.00007	11.75098	59
2	8.25609	9.99993	8.25617	11.74384	10.00007	11.74391	58
3	8.26304	9.99993	8.26312	11.73689	10.00007	11.73096	57
4	8.26988	9.99993	8.26996	11.73004	10.00007	11.73012	56
5	8.27661	9.99992	8.27669	11.72331	10.00008	11.72339	55
6	8.28324	9.99992	8.28332	11.71668	10.00008	11.71676	54
7	8.28977	9.99992	8.28986	11.71014	10.00008	11.71023	53
8	8.29621	9.99992	8.29629	11.70371	10.00009	11.70379	52
9	8.30255	9.99991	8.30263	11.69737	10.00009	11.69745	51
10	8.30879	9.99991	8.30888	11.69112	10.00009	11.69121	50
11	8.31495	9.99991	8.31505	11.68495	10.00009	11.68505	49
12	8.32103	9.99991	8.32112	11.67888	10.00010	11.67897	48
13	8.32702	9.99990	8.32711	11.67289	10.00010	11.67298	47
14	8.33292	9.99990	8.33303	11.66698	10.00010	11.66708	46
15	8.33875	9.99990	8.33886	11.66114	10.00010	11.66125	45
16	8.34450	9.99989	8.34461	11.65539	10.00011	11.65550	44
17	8.35018	9.99989	8.35029	11.64971	10.00011	11.64982	43
18	8.35578	9.99989	8.35590	11.64411	10.00011	11.64422	42
19	8.36132	9.99989	8.36143	11.63857	10.00012	11.63869	41
20	8.36678	9.99988	8.36689	11.63311	10.00012	11.63322	40
21	8.37217	9.99988	8.37229	11.62771	10.00012	11.62783	39
22	8.37750	9.99988	8.37762	11.62238	10.00012	11.62250	38
23	8.38276	9.99987	8.38289	11.61711	10.00013	11.61724	37
24	8.38796	9.99987	8.38809	11.61191	10.00013	11.61204	36
25	8.39310	9.99987	8.39323	11.60677	10.00013	11.60690	35
26	8.39818	9.99986	8.39832	11.60169	10.00014	11.60182	34
27	8.40320	9.99986	8.40334	11.59666	10.00014	11.59680	33
28	8.40816	9.99986	8.40830	11.59170	10.00014	11.59184	32
29	8.41307	9.99985	8.41321	11.58679	10.00015	11.58693	31
30	8.41792	9.99985	8.41807	11.58193	10.00015	11.58208	30
		Sine.		Tang.		Secant	Min.

88 *Degrees*.

Tangents and Secants.

1 Degree.

Min.	Sine.		Tang.		Secant.		
30	8.41792	9.99985	8.41807	11.58193	10.00015	11.58208	30
31	8.42272	9.99985	8.42287	11.57713	10.00015	11.57728	29
32	8.42746	9.99984	8.42762	11.57238	10.00016	11.57254	28
33	8.43216	9.99984	8.43232	11.56769	10.00016	11.56784	27
34	8.43680	9.99984	8.43696	11.56304	10.00016	11.56320	26
35	8.44139	9.99983	8.44156	11.55844	10.00017	11.55861	25
36	8.44594	9.99983	8.44611	11.55389	10.00017	11.55406	24
37	8.45044	9.99983	8.45061	11.54939	10.00017	11.54956	23
38	8.45489	9.99982	8.45507	11.54493	10.00018	11.54511	22
39	8.45930	9.99982	8.45948	11.54052	10.00018	11.54070	21
40	8.46366	9.99982	8.46385	11.53615	10.00018	11.53634	20
41	8.46799	9.99981	8.46817	11.53183	10.00019	11.53202	19
42	8.47226	9.99981	8.47245	11.52755	10.00019	11.52774	18
43	8.47650	9.99981	8.47669	11.52331	10.00020	11.52350	17
44	8.48069	9.99980	8.48089	11.51911	10.00020	11.51931	16
45	8.48485	9.99980	8.48505	11.51495	10.00020	11.51515	15
46	8.48896	9.99979	8.48917	11.51083	10.00021	11.51104	14
47	8.49304	9.99979	8.49325	11.50675	10.00021	11.50696	13
48	8.49708	9.99979	8.49729	11.50271	10.00021	11.50292	12
49	8.50108	9.99978	8.50130	11.49870	10.00022	11.49892	11
50	8.50505	9.99978	8.50527	11.49473	10.00022	11.49496	10
51	8.50897	9.99977	8.50920	11.49080	10.00023	11.49103	9
52	8.51287	9.99977	8.51310	11.48690	10.00023	11.48713	8
53	8.51673	9.99977	8.51696	11.48304	10.00024	11.48327	7
54	8.52055	9.99976	8.52079	11.47921	10.00024	11.47945	6
55	8.52434	9.99976	8.52459	11.47541	10.00024	11.47566	5
56	8.52810	9.99975	8.52835	11.47165	10.00025	11.47190	4
57	8.53183	9.99975	8.53208	11.46792	10.00025	11.46817	3
58	8.53552	9.99974	8.53578	11.46422	10.00026	11.46448	2
59	8.53919	9.99974	8.53945	11.46055	10.00026	11.46081	1
60	8.54282	9.99974	8.54308	11.45692	10.00027	11.45718	0
		Sine.		Tang.		Secant.	Min.

88 Degrees.

A Table of Artificial Sines,

2 Degrees.

Min.	Sine.		Tang.		Secant.		
0	8.54282	9.69974	8.54308	11.45692	10.00027	11.45718	60
1	8.54642	9.99973	8.54669	11.45331	10.00027	11.45358	59
2	8.55000	9.99973	8.55027	11.44973	10.00027	11.45091	58
3	8.55354	9.99972	8.55382	11.44618	10.00928	11.44646	57
4	8.55705	9.99972	8.55734	11.44266	10.00028	11.44295	56
5	8.56054	9.99971	8.56083	11.43917	10.00029	11.43946	55
6	8.56400	9.99970	8.56429	11.43571	10.00029	11.43600	54
7	8.56743	9.99970	8.56773	11.43227	10.00030	11.43257	53
8	8.57084	9.99970	8.57114	11.42886	10.00030	11.42916	52
9	8.57421	9.99969	8.57452	11.42548	10.00030	11.42579	51
10	8.57757	9.99969	8.57788	11.42212	10.00031	11.42243	50
11	8.58089	9.99968	8.58121	11.41879	10.00032	11.41911	49
12	8.58419	9.99968	8.58451	11.41549	10.00032	11.41581	48
13	8.58747	9.99968	8.58779	11.41221	10.00033	11.41253	47
14	8.59072	9.69967	8.59105	11.40895	10.00033	11.40928	46
15	8.59395	9.99967	8.59428	11.40572	10.00034	11.40605	45
16	8.59715	9.99966	8.59749	11.40251	10.00034	11.40285	44
17	8.60033	9.99966	8.60068	11.39932	10.00035	11.39967	43
18	8.60349	9.99965	8.60384	11.39616	10.00035	11.39651	42
19	8.60662	9.99965	8.60698	11.39302	10.00036	11.39338	41
20	8.60973	9.99964	8.61009	91.38991	10.00036	11.39027	40
21	8.61282	9.99964	8.61319	11.38681	10.00037	11.38718	39
22	8.61589	9.99963	8.61626	11.38374	10.00037	11.38411	38
23	8.61894	9.99962	8.61931	11.38069	10.00038	11.38106	37
24	8.62196	9.99962	8.62234	11.37766	10.00038	11.37804	36
25	8.62497	9.99961	8.62535	11.37465	10.00039	11.37504	35
26	8.62795	9.99960	8.62834	11.37166	10.00039	11.37205	34
27	8.62091	9.99960	8.63131	11.36869	10.00040	11.36909	33
28	8.63385	9.99960	8.63426	11.36574	10.00040	11.36615	32
29	8.63678	9.99960	8.63718	11.36282	10.00041	11.36322	31
30	8.63968	9.99959	8.64009	11.35991	10.00041	11.36032	30
		Sine.		Tang.		Secant.	Min.

87 Degrees.

Tangents and Secants.

2 Degrees.

Min.	Sine.		Tang.		Secant.		
30	8.63968	9.99959	8.64009	11.35991	10.00041	11.36032	30
31	8.64256	9.99958	8.64298	11.35702	10.00042	11.35744	19
32	8.64543	9.99958	8.64585	11.35415	10.00043	11.35457	28
33	8.64827	9.99957	8.64870	11.35130	10.00043	11.35173	27
34	8.65110	9.99956	8.65154	11.34846	10.00044	11.34890	26
35	8.65391	9.99956	8.65435	11.34565	10.00044	11.34609	25
36	8.65670	9.99955	8.65715	11.34285	10.00045	11.34330	24
37	8.65948	9.99955	8.65993	11.34007	10.00045	11.34053	23
38	8.66223	9.99954	8.66269	11.33731	10.00046	11.33777	22
39	8.66497	9.99954	8.66543	11.33457	10.00047	11.33503	21
40	8.66769	9.99953	8.66816	11.33184	10.00047	11.33231	20
41	8.67039	9.99952	8 67087	11.32913	10.00048	11.32961	19
42	8.67308	9.99952	8.67356	11.32644	10.00048	11.32692	18
43	8.6757[illegible]	9.99951	8.67624	11.32376	10.00049	11.32425	17
44	8.67841	9.99951	8.67890	11.32110	10.00049	11.32160	16
45	8.68104	9.99950	8.68154	11.31846	10.00050	11.31896	15
46	8.68367	9.99949	8.68417	11.31583	10.00051	11.31634	14
47	8.68627	9.99949	8.68678	11.31322	10.00051	11.31373	13
48	8.68886	9.99948	8.68938	11.31062	10.00052	11.31114	12
49	8.69144	9.99948	8.6916[illegible]	11.30804	10.00053	11.30857	11
50	8.69400	9.99947	8.69453	11.30547	10.00053	11.30600	10
51	8.69654	9.99946	8.69708	11.30292	10.00054	11.30346	9
52	8.69907	9.99946	8.69962	11.30038	10.00054	11.30093	8
53	8.70159	9.99945	8.70214	11.29786	10.00055	11.29841	7
54	8.70409	9.99944	8.70465	11.29535	10.00056	11.29591	6
55	8.70658	9.99944	8.70714	11.29286	10.00056	11.29342	5
56	8.70905	9.99943	8.70962	11.29038	10.00057	11.29095	4
57	8.71151	9.99942	8.71208	11.28792	10.00058	11.28849	3
58	8.71395	9.99942	8.71453	11.28547	10.00058	11.28605	2
59	8.71638	9.99941	8.71697	11.28303	10.00059	11.28362	1
60	8.71880	9.99940	8.71940	11.28060	10.00060	11.28120	0
		Sine.		Tang.		Secant.	Min.

87 Degrees.

Tangents and Secants.

3 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	8.785[illegible]	[illegible].99919	8.78649	11.21351	10.00081	11.21433	30
31	8.787[illegible]	9.99918	8.78855	11.21145	0.00082	11.21226	29
32	8.78979	9.99917	8.79061	11.20939	0.00083	11.21021	28
33	8.79183	9.99917	8.79266	11.20734	10.00083	11.20817	27
34	8.79386	9.99916	8.79470	11.20530	10.00084	11.20614	26
35	8.79588	9.99915	8.79673	11.20327	10.00085	11.20412	25
36	8.79789	9.99914	8.79875	11.20125	10.00086	11.20211	24
37	8.79990	9.99913	8.80076	11.19924	10.00087	11.20010	23
38	8.80189	9.99913	8.80277	11.19724	10.00087	11.19811	22
39	8.80388	9.99912	8.80476	11.19524	10.00088	11.19612	21
40	8.80585	9.99911	8.80674	11.19326	10.00089	11.19415	20
41	8.80782	9.99910	8.80872	11.19128	10.00090	11.19218	19
42	8.80978	9.99909	8.81068	11.18932	10.00091	11.19022	18
43	8.81173	9.99909	8.81264	11.18736	10.00091	11.18827	17
44	8.81367	9.99908	8.81459	11.18541	10.00092	11.18633	16
45	8.81560	9.99907	8.81653	11.18347	10.00094	11.18440	15
46	8.81752	9.99906	8.81846	11.18154	10.00094	11.18248	14
47	8.81944	9.99905	8.82038	11.17962	10.00095	11.18056	13
48	8.82134	9.99904	8.82230	11.17770	10.00096	11.17866	12
49	8.82324	9.99904	8.82421	11.17580	0.00096	1.17676	11
50	8.82513	9.99903	8.82610	11.17390	10.00097	11.17487	10
51	8.82701	9.99902	8.82799	11.17201	10.00098	11.17299	9
52	8.82888	9.99901	8.82987	11.17013	10.00099	11.17112	8
53	8.83075	9.99900	8.83175	11.16825	10.00100	11.16925	7
54	8.83261	9.99899	8.83361	11.16639	10.00101	11.16739	6
55	8.83446	9.99898	8.83547	11.16453	10.00102	11.16554	5
56	8.83630	9.99898	8.83732	11.16268	10.00102	11.16370	4
57	8.83813	9.99897	8.83916	11.16084	10.00103	11.16187	3
58	8.83996	9.99896	8.84100	11.15900	10.00104	11.16004	2
59	8.84177	9.99895	8.84282	11.15718	10.00105	11.15823	1
60	8.84358	9.99894	8.84464	11.15536	10.00106	11.15642	0
		Sine.		Tang.		Secant.	Min.

86 *Degrees.*

A Table of Artificial Sines,

4 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	8.84358	9.99894	8.84464	11.15536	10.00106	11.15642	60
1	8.84539	9.99893	8.84646	11.15355	10.00107	11.15461	59
2	8.84718	9.99892	8.84826	11.15174	10.00108	11.15282	58
3	8.84897	9.99891	8.85006	11.14994	10.00109	11.15103	57
4	8.85075	9.99891	8.85185	11.14815	10.00110	11.14925	56
5	8.85252	9.99890	8.85363	11.14637	10.00110	11.14748	55
6	8.85429	9.99889	8.85540	11.14460	10.00111	11.14571	54
7	8.85605	9.99888	8.85717	11.14283	10.00112	11.14395	53
8	8.85780	9.99887	8.85893	11.14107	10.00113	11.14220	52
9	8.85995	9.99886	8.86069	11.13931	10.00114	11.14055	51
10	8.86128	9.99885	8.86243	11.13757	10.00115	11.13872	50
11	8.86301	9.99884	8.86417	11.13583	10.00116	11.13699	49
12	8.86474	9.99883	8.86591	11.13409	10.00117	11.13526	48
13	8.86645	9.99882	8.86763	11.13237	10.00118	11.13355	47
14	8.86817	9.99881	8.86935	11.13065	10.00119	11.13184	46
15	8.86987	9.99880	8.87106	11.12894	10.00120	11.13013	45
16	8.87157	9.99880	8.87277	11.12723	10.00121	11.12844	44
17	8.87326	9.99879	8.87447	11.12553	10.00122	11.12675	43
18	8.87494	9.99878	8.87616	11.12384	10.00122	11.12506	42
19	8.87662	9.99877	8.87785	11.12215	10.00123	11.12339	41
20	8.87829	9.99876	8.87953	11.12047	10.00124	11.12172	40
21	8.87995	9.99875	8.88120	11.11880	10.00125	11.12005	39
22	8.88161	9.99874	8.88287	11.11713	10.00126	11.11839	38
23	8.88326	9.99873	8.88453	11.11547	10.00127	11.11674	37
24	8.88490	9.99872	8.88619	11.11382	10.00128	11.11510	36
25	8.88654	9.99871	8.88783	11.11217	10.00129	11.11346	35
26	8.88817	9.99870	8.88948	11.11052	10.00130	11.11183	34
27	8.88980	9.99869	8.89111	11.10889	10.00131	11.11020	33
28	8.89142	9.99868	8.89274	11.10726	10.00132	11.10858	32
29	8.89304	9.99867	8.89437	11.10563	10.00133	11.10697	31
30	8.89464	9.99866	8.89598	11.10402	10.00134	11.10536	30
		Sine.		Tang.		Secant.	Min.

85 *Degrees.*

4 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	8.89464	9.99866	8.89598	11.10402	10.00134	11.10536	30
31	8.89625	9.99865	8.89760	11.10240	10.00135	11.10375	29
32	8.89784	9.99864	8.89920	11.10080	10.00136	11.10216	28
33	8.89943	9.99863	8.90080	11.09920	10.00137	11.10057	27
34	8.90102	9.99862	8.90240	11.09760	10.00138	11.09898	26
35	8.90260	9.99861	8.90399	11.09601	10.00139	11.09740	25
36	8.90417	9.99860	8.90557	11.09443	10.00140	11.09583	24
37	8.90574	9.99859	8.90715	11.09285	10.00141	11.09426	23
38	8.90730	9.99858	8.90872	11.09128	10.00142	11.09270	22
39	8.90885	9.99857	8.91029	11.08972	10.00143	11.09115	21
40	8.91040	9.99856	8.91185	11.08815	10.00144	11.08960	20
41	8.91195	9.99855	8.91340	11.08660	10.00145	11.08805	19
42	8.91349	9.99854	8.91495	11.08505	10.00146	11.08651	18
43	8.91502	9.99853	8.91650	11.08351	10.00147	11.08498	17
44	8.91655	9.99852	8.91803	11.08197	10.00148	11.08345	16
45	8.91807	9.99851	8.91957	11.08043	10.00149	11.08193	15
46	8.91959	9.99850	8.92116	11.07890	10.00151	11.08041	14
47	8.92110	9.99849	8.92262	11.07738	10.00152	11.07890	13
48	8.92261	9.99847	8.92414	11.07586	10.00153	11.07739	12
49	8.92411	9.99846	8.92565	11.07435	10.00154	11.07589	11
50	8.92561	9.99845	8.92716	11.07285	10.00155	11.07439	10
51	8.92710	9.99844	8.92866	11.07134	10.00156	11.07290	9
52	8.92859	9.99843	8.93016	11.06985	10.00157	11.07141	8
53	8.93007	9.99842	8.93165	11.06835	10.00158	11.06993	7
54	8.93154	9.99841	8.93313	11.06687	10.00159	11.06846	6
55	8.93302	9.99840	8.93462	11.06538	10.00160	11.06699	5
56	8.93448	9.99839	8.93609	11.06391	10.00161	11.06552	4
57	8.93594	9.99838	8.93757	11.06244	10.00162	11.06406	3
58	8.93740	9.99837	8.93903	11.06097	10.00163	11.06260	2
59	8.93885	9.99836	8.94049	11.05951	10.00165	11.06115	1
60	8.94030	9.99834	8.94195	11.05805	10.00166	11.05970	0
		Sine.		Tang.		Secant.	Min.

85 *Degrees.*

A Table of Artificial Sines,

5 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	8.94030	9.99834	8.94195	11.05805	10.00166	11.05970	60
1	8.94174	9.99833	8.94340	11.05660	10.00167	11.05826	59
2	8.94317	9.99832	8.94485	11.05515	10.00168	11.05683	58
3	8.94461	9.99831	8.94630	11.05371	10.00169	11.05539	57
4	8.94603	9.99830	8.94773	11.05227	10.00170	11.05397	56
5	8.94746	9.99829	8.94917	11.05083	10.00171	11.05254	55
6	8.94887	9.99828	8.95060	11.04940	10.00172	11.05113	54
7	8.95029	9.99827	8.95202	11.04798	10.00173	11.04971	53
8	8.95170	9.99826	8.95344	11.04656	10.00175	11.04830	52
9	8.95310	9.99824	8.95486	11.04514	10.00176	11.04690	51
10	8.95450	9.99823	8.95627	11.04373	10.00177	11.04550	50
11	8.95590	9.99822	8.95767	11.04233	10.00178	11.04411	49
12	8.95728	9.99821	8.95908	11.04093	10.00179	11.04272	48
13	8.95867	9.99820	8.96047	11.03953	10.00180	11.04133	47
14	8.96005	9.99810	8.96180	11.038[illegible]3	10.00181	11.03995	46
15	8.96143	9.99817	8.96325	11.03675	10.00183	11.03857	45
16	8.96280	9.99816	8.96464	11.03536	10.00184	11.03720	44
17	8.96417	9.99815	8.96602	11.03398	10.00185	11.03583	43
18	8.96553	9.99814	8.96739	11.03261	10.00186	11.03447	42
19	8.96689	9.99813	8.96877	11.03123	10.00187	11.03311	41
20	8.96825	9.99812	8.97013	11.02987	10.00188	11.03175	40
21	8.96960	9.99810	8.97150	11.02850	10.00190	11.03040	39
22	8.97095	9.99809	8.97286	11.02715	10.00191	11.02905	38
23	8.97229	9.99808	8.97421	11.02579	10.00192	11.02771	37
24	8.97363	9.99807	8.97556	11.02444	10.00193	11.02637	36
25	8.97496	9.99806	8.97691	11.02309	10.00194	11.02504	35
26	8.97629	9.99804	8.97825	11.02175	10.00196	11.02371	34
27	8.97762	9.99803	8.97959	11.02041	10.00197	11.02238	33
28	8.97894	9.99802	8.98092	11.01908	10.00198	11.02106	32
29	8.98026	9.99801	8.98225	11.01775	10.00199	11.01974	31
30	8.98157	9.99800	8.98358	11.01642	10.00200	11.01843	30
		Sine.		Tang.		Secant.	Min.

84 *Degrees.*

Tangents and Secants.

5 Degrees.

Min.	Sine.		Tang.		Secant.		
30	8.98157	9.99800	8.98358	11.01642	10.00200	11.01843	30
31	8.98288	9.99798	8.98490	11.01510	10.00202	11.01712	29
32	8.98419	9.99797	8.98622	11.01378	10.00203	11.01581	28
33	8.98549	9.99796	8.98753	11.01247	10.00204	11.01451	27
34	8.98679	9.99795	8.98884	11.01116	10.00205	11.01321	26
35	8.98808	9.99794	8.99015	11.00985	10.00207	11.01192	25
36	8.98937	9.99792	8.99145	11.00855	10.00208	11.01063	24
37	8.99066	9.99791	8.99275	11.00725	10.00209	11.00934	23
38	8.99194	9.99790	8.99405	11.00596	10.00210	11.00806	22
39	8.99322	9.99789	8.99534	11.00466	10.00213	11.00678	21
40	8.99450	9.99787	8.99662	11.00338	10.00213	11.00550	20
41	8.99577	9.99786	8.99791	11.00209	10.00214	11.00423	19
42	8.99704	9.99785	8.99919	11.00081	10.00215	11.00296	18
43	8.99830	9.99784	9.00047	10.99954	10.00217	11.00170	17
44	8.99956	9.99782	9.00174	10.99826	10.00218	11.00044	16
45	9.00082	9.99781	9.00301	10.99699	10.00220	10.99918	15
46	9.00207	9.99780	9.00427	10.99573	10.00220	10.99793	14
47	9.00332	9.99778	9.00553	10.99447	10.00222	10.99668	13
48	9.00456	9.99777	9.00679	10.99321	10.00223	10.99544	12
49	9.00581	9.99776	9.00805	10.99195	10.00224	10.99420	11
50	9.00704	9.99775	9.00930	10.99070	10.00226	10.99296	10
51	9.00828	9.99773	9.01055	10.98945	10.00227	10.99172	9
52	9.00951	9.99772	9.01179	10.98821	10.00228	10.99049	8
53	9.01074	9.99771	9.01303	10.98697	10.00229	10.98926	7
54	9.01196	9.99769	9.01427	10.98573	10.00231	10.98804	6
55	9.0131	9.99768	9.01550	10.98450	10.00232	10.98682	5
56	9.01440	9.99767	9.01673	10.98327	10.00233	10.98560	4
57	9.01561	9.99765	9.01796	10.98204	10.00235	10.98439	3
58	9.01682	9.99764	9.01918	10.98082	10.00236	10.98318	2
59	9.01803	9.99763	9.02040	10.97960	10.00237	10.98197	1
60	9.01923	9.99761	9.02162	0.97839	10.00239	10.98077	0
		S ne		Tang.		Secant.	Min.

84 Degrees.

A Table of Artificial Sines,

6 Degrees.

Min.	Sine.		Tang.		Secant.		
0	9.01924	9.99761	9.02162	10.97838	10.00239	10.98077	60
1	9.02044	9.99760	9.02283	10.97717	10.00240	10.97957	59
2	9.02163	9.99759	9.02404	10.97596	10.00241	10.97837	58
3	9.02283	9.99757	9.02525	10.97475	10.00243	10.97718	57
4	9.02402	9.99756	9.02646	10.97355	10.00244	10.97598	56
5	9.02520	9.99755	9.02766	10.97235	10.00245	10.97480	55
6	9.02639	9.99753	9.02885	10.97115	10.00247	10.97361	54
7	9.02757	9.99752	9.03005	10.96995	10.00248	10.97243	53
8	9.02874	9.99751	9.03124	10.96876	10.00249	10.97126	52
9	9.02992	9.99749	9.03243	10.96758	10.00251	10.97008	51
10	9.03109	9.99748	9.03361	10.96639	10.00252	10.96891	50
11	9.03226	9.99747	9.03479	10.96521	10.00253	10.96774	49
12	9.03342	9.99745	9.03597	10.96403	10.00255	10.96658	48
13	9.03458	9.99744	9.03714	10.96286	10.00256	10.96542	47
14	9.03574	9.69743	9.03832	10.96168	10.00258	10.96426	46
15	9.03690	9.99741	9.03949	10.96052	10.00259	10.96310	45
16	9.03805	9.99740	9.04065	10.95935	10.00260	10.96195	44
17	9.03920	9.99738	9.04181	10.95819	10.00262	10.96080	43
18	9.04034	9.99737	9.04297	10.95703	10.00263	10.95966	42
19	9.04149	9.99736	9.04413	10.95587	10.00265	10.95852	41
20	9.04263	9.99734	9.04528	10.95472	10.00266	10.95738	40
21	9.04376	9.99733	9.04643	10.95357	10.00267	10.95624	39
22	9.04490	9.99731	9.04758	10.95242	10.00269	10.95511	38
23	9.04603	9.99730	9.04873	10.95127	10.00270	10.95397	37
24	9.04715	9.99729	9.04987	10.95013	10.00272	10.95285	36
25	9.04828	9.99727	9.05101	10.94899	10.00273	10.95172	35
26	9.04940	9.99726	9.05214	10.94786	10.00274	10.95060	34
27	9.05052	9.99724	9.05328	10.94672	10.00276	10.94948	33
28	9.05164	9.99723	9.05441	10.94559	10.00277	10.94837	32
29	9.05275	9.99721	9.05554	10.94447	10.00279	10.94725	31
30	9.05386	9.99720	9.05666	10.94334	10.00280	10.94614	30
		Sine.		Tang.		Secant.	Min.

83 Degrees.

Tangents and Secants.

6 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.05386	9.99720	9.05666	10.94334	10.00280	10.94614	30
31	9.05497	9.99719	9.05778	10.94222	10.00282	10.94503	29
32	9.05607	9.99717	9.05890	10.94110	10.00283	10.94393	28
33	9.05717	9.99716	9.06002	10.93998	10.00284	10.94284	27
34	9.05827	9.99714	9.06113	10.93887	10.00286	10.94173	26
35	9.05937	9.99713	9.06224	10.93776	10.00287	10.94063	25
36	9.06046	9.99711	9.06335	10.93665	10.00289	10.93954	24
37	9.06155	9.99710	9.06445	10.93555	10.00290	10.93845	23
38	9.06264	9.99708	9.06556	10.93444	10.00292	10.93736	22
39	9.06372	9.99707	9.06666	10.93335	10.00293	10.93628	21
40	9.06481	9.99705	9.06775	10.93225	10.00295	10.93519	20
41	9.06589	9.99704	9.06885	10.93115	10.00296	10.93412	19
42	9.06696	9.99702	9.06994	10.93006	10.00298	10.93304	18
43	9.06804	9.99701	9.07103	10.92897	10.00299	10.93196	17
44	9.06911	9.99699	9.07211	10.92789	10.00301	10.93089	16
45	9.07018	9.99698	9.07320	10.92680	10.00302	10.92982	15
46	9.07124	9.99696	9.07428	10.92572	10.00304	10.92876	14
47	9.07231	9.99695	9.07536	10.92464	10.00305	10.92769	13
48	9.07337	9.99693	9.07643	10.92357	10.00307	10.92663	12
49	9.07442	9.99692	9.07751	10.92245	10.00308	10.92558	11
50	9.07548	9.99690	9.07858	10.92142	10.00310	10.92452	10
51	9.07653	9.99689	9.07964	10.92036	10.00311	10.92347	9
52	9.07758	9.99687	9.08071	10.91929	10.00313	10.92242	8
53	9.07863	9.99686	9.08177	10.91823	10.00314	10.92137	7
54	9.07968	9.99684	9.08283	10.91717	10.00316	10.92032	6
55	9.08072	9.99683	9.08389	10.91611	10.00317	10.91928	5
56	9.08176	9.99681	9.08495	10.91505	10.00319	10.9182[illegible]	4
57	9.08280	9.99680	9.08600	10.91400	10.00320	10.91720	3
58	9.08383	9.99678	9.08705	10.91295	10.00322	10.91617	2
59	9.08486	9.99677	9.08810	10.91190	10.00323	10.91514	1
60	9.08589	9.99675	9.08914	10.91086	10.00325	10.9141[illegible]	0
		Sine.		Tang.		Secant.	Min.

83 *Degrees.*

A Table of Artificial Sines,

7 Degrees.

Min.	Sine.		Tang.		Secant.		
0	9.08589	9.99675	9.08914	10.91086	10.00325	10.91411	60
1	9.08692	9.99674	9.09019	10.90981	10.00327	10.91308	59
2	9.08795	9.99672	9.09123	10.90877	10.00328	10.91205	58
3	9.08897	9.99670	9.09227	10.90773	10.00330	10.91103	57
4	9.08999	9.99669	9.09330	10.90670	10.00331	10.91001	56
5	9.09101	9.99667	9.09434	10.90566	10.00333	10.90899	55
6	9.09202	9.99666	9.09537	10.90463	10.00334	10.90798	54
7	9.09304	9.99664	9.09640	10.90360	10.00336	10.90696	53
8	9.09405	9.99663	9.09740	10.90258	10.00338	10.90595	52
9	9.09506	9.99661	9.09845	10.90155	10.00339	10.90494	51
10	9.09606	9.99659	9.09947	10.90053	10.00341	10.90394	50
11	9.09707	9.99658	9.10049	10.89951	10.00342	10.90294	49
12	9.09807	9.99656	9.10150	10.89850	10.00344	10.90193	48
13	9.09907	9.99655	9.10252	10.89748	10.00345	10.90094	47
14	9.10006	9.99653	9.10353	10.89647	10.00347	10.89994	46
15	9.10106	9.99651	9.10454	10.89546	10.00349	10.89894	45
16	9.10205	9.99650	9.10555	10.89445	10.00350	10.89795	44
17	9.10304	9.99648	9.10656	10.89344	10.00352	10.89696	43
18	9.10403	9.99647	9.10756	10.89244	10.00353	10.89598	42
19	9.10501	9.99644	9.10856	10.89144	10.00355	10.89499	41
20	9.10599	9.99643	9.10956	10.89044	10.00357	10.89401	40
21	9.10697	9.99642	9.11056	10.88944	10.00358	10.89303	39
22	9.10795	9.99640	9.11155	10.88845	10.00360	10.89205	38
23	9.10893	9.99638	9.11254	10.88746	10.00362	10.89107	37
24	9.10990	9.99637	9.11353	10.88647	10.00363	10.89010	36
25	9.11087	6.99635	9.11452	10.88548	10.00365	10.88913	35
26	9.11184	9.99634	9.11551	10.88449	10.00367	10.88816	34
27	9.11281	9.99632	9.11649	10.88351	10.00368	10.88719	33
28	9.11377	9.99630	9.11747	10.88253	10.00370	10.88623	32
29	9.11474	9.99629	9.11845	10.88155	10.00372	10.88526	31
30	9.11570	9.99627	9.11943	10.88057	10.00373	10.88430	30
		Sine.		Tang.		Secant.	Min.

82 Degrees.

Tangents and Secants.

8 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.16970	9.99520	9.17450	10.82550	10.00480	10.83030	30
31	9.17055	9.99518	9.17536	10.82464	10.00482	10.82945	29
32	9.17139	9.99517	9.17622	10.82378	10.00484	10.82861	28
33	9.17223	9.99515	9.17708	10.82292	10.00485	10.82777	27
34	9.17307	9.99513	9.17794	10.82206	10.00487	10.82693	26
35	9.17391	9.99511	9.17880	10.82120	10.00489	10.82609	25
36	9.17474	9.99509	9.17966	10.82035	10.00491	10.82526	24
37	9.17558	9.99507	9.18051	10.81949	10.00493	10.82442	23
38	9.17641	9.99505	9.18136	10.81864	10.00495	10.82359	22
39	9.17724	9.99503	9.18221	10.81779	10.00497	10.82276	21
40	9.17807	9.99501	9.18306	10.81694	10.00499	10.82193	20
41	9.17890	9.99499	9.18391	10.81609	10.00501	10.82111	19
42	9.17973	9.99497	9.18475	10.81525	10.00503	10.82027	18
43	9.18055	9.99496	9.18560	10.81440	10.00505	10.81949	17
44	9.18137	9.69494	9.18644	10.81356	10.00507	10.81863	16
45	9.18220	9.99492	9.18728	10.81272	10.00508	10.81780	15
46	9.18302	9.99490	9.18812	10.81188	10.00510	10.81698	14
47	9.18383	9.99488	9.18896	10.81104	10.00512	10.81617	13
48	9.18465	9.99486	9.18979	10.81021	10.00514	10.81535	12
49	9.18547	9.99484	9.19063	10.80937	10.00516	10.81453	11
50	9.18628	9.99482	9.19146	10.80854	10.00518	10.81372	10
51	9.18709	9.99480	9.19229	10.80771	10.00520	10.81291	9
52	9.18790	9.99478	9.19312	10.80688	10.00522	10.81210	8
53	9.18871	9.99476	9.19395	10.80605	10.00524	10.81129	7
54	9.18952	9.99474	9.19478	10.80522	10.00526	10.81048	6
55	9.19033	9.99473	9.19561	10.80439	10.00528	10.80968	5
56	9.19113	9.99470	9.19643	10.80357	10.00530	10.80887	4
57	9.19193	9.99468	9.19725	10.80275	10.00532	10.80807	3
58	9.19273	9.99466	9.19807	10.80193	10.00534	10.80727	2
59	9.19353	9.99464	9.19889	10.80111	10.00536	10.80647	1
60	9.19433	9.99462	9.19971	10.80029	10.00538	10.80567	0
		Sine.		Tang.		Secant.	Min.

81 *Degrees.*

A Table of Artificial Sines,

9 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.19433	9.99462	9.19971	10.80029	10.00538	10.80567	60
1	9.19513	9.99460	9.20053	10.79947	10.00540	10.80488	59
2	9.19593	9.99458	9.20135	10.79866	10.00542	10.80408	58
3	9.19672	9.99456	9.20216	10.79784	10.00544	10.80328	57
4	9.19751	9.99454	9.20297	10.79703	10.00546	10.80249	56
5	9.19830	9.99452	9.20378	10.79622	10.00548	10.80170	55
6	9.19909	9.99450	9.20459	10.79541	10.00550	10.80091	54
7	9.19988	9.99448	9.20540	10.79460	10.00552	10.80012	53
8	9.20067	9.99446	9.20621	10.79379	10.00554	10.79933	52
9	9.20145	9.99444	9.20701	10.79299	10.00556	10.79855	51
10	9.20223	9.99442	9.20782	10.79218	10.00558	10.79777	50
11	9.20302	9.99440	9.20862	10.79138	10.00560	10.79698	49
12	9.20380	9.99438	9.20942	10.79058	10.00562	10.79620	48
13	9.20458	9.99436	9.21022	10.78978	10.00564	10.79542	47
14	9.20535	9.99434	9.21102	10.78898	10.00566	10.79465	46
15	9.20613	9.99432	9.21182	10.78819	10.00568	10.79387	45
16	9.20691	9.99430	9.21261	10.78739	10.00571	10.79309	44
17	9.20768	9.99427	9.21341	10.78660	10.00572	10.79232	43
18	9.20845	9.99425	9.21420	10.78580	10.00575	10.79155	42
19	9.20922	9.99423	9.21499	10.78501	10.00577	10.79078	41
20	9.20999	9.99421	9.21578	10.78422	10.00579	10.79001	40
21	9.21076	9.99419	9.21657	10.78343	10.00581	10.78924	39
22	9.21153	9.99417	9.21736	10.78264	10.00583	10.78847	38
23	9.21229	9.99415	9.21814	10.78186	10.00585	10.78771	37
24	9.21306	9.99413	9.21893	10.78107	10.00587	10.78695	36
25	9.21382	9.99411	9.21971	10.78029	10.00589	10.78618	35
26	9.21458	9.99409	9.22049	10.77951	10.00591	10.78542	34
27	9.21534	9.99407	9.22127	10.77873	10.00593	10.78466	33
28	9.21610	9.99405	9.22205	10.77795	10.00596	10.78390	32
29	9.21685	9.99402	9.22283	10.77717	10.00598	10.78315	31
30	9.21761	9.99400	9.22361	10.77639	10.00600	10.78239	30
		Sine.		Tang.		Secant.	Min.

80 *Degrees.*

Tangents and Secants.

9 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.21761	9.99400	9.22361	10.77639	10.00600	10.78239	30
31	9.21836	9.99398	9.22438	10.77562	10.00602	10.78164	29
32	9.21912	9.99396	9.22516	10.77484	10.00604	10.78088	28
33	9.21987	9.99394	9.22593	10.77407	10.00606	10.78013	27
34	9.22062	9.99392	9.22670	10.77330	10.00608	10.77938	26
35	9.22137	9.99390	9.22747	10.77253	10.00610	10.77863	25
36	9.22211	9.99388	9.22824	10.77176	10.00613	10.77789	24
37	9.22286	9.99385	9.22901	10.77099	10.00615	10.77714	23
38	9.22361	9.99383	9.22977	10.77023	10.00617	10.77639	22
39	9.22435	9.99381	9.23054	10.76946	10.00619	10.77565	21
40	9.22509	9.99379	9.23131	10.76870	10.00621	10.77491	20
41	9.22583	9.99377	9.23207	10.76794	10.00623	10.77417	19
42	9.22657	9.99375	9.23283	10.76717	10.00625	10.77343	18
43	9.22731	9.99373	9.23359	10.76641	10.00628	10.77269	17
44	9.22805	9.99370	9.23435	10.76566	10.00630	10.77195	16
45	9.22878	9.99368	9.23510	10.76490	10.00632	10.77122	15
46	9.22952	9.99366	9.23586	10.76414	10.00634	10.77048	14
47	9.23025	9.99364	9.23661	10.76339	10.00636	10.76975	13
48	9.23098	9.99362	9.23737	10.76263	10.00638	10.76902	12
49	9.23171	9.99359	9.23812	10.76188	10.00641	10.76829	11
50	9.23244	9.99357	9.23887	10.76113	10.00643	10.76756	10
51	9.23317	9.99355	9.23962	10.76038	10.00645	10.76683	9
52	9.23390	9.99353	9.24037	10.75963	10.00647	10.76610	8
53	9.23462	9.99351	9.24112	10.75888	10.00649	10.76538	7
54	9.23535	9.99348	9.24187	10.75814	10.00652	10.76465	6
55	9.23607	9.99346	9.24261	10.75739	10.00654	10.76393	5
56	9.23680	9.99344	9.24335	10.75665	10.00656	10.76321	4
57	9.23752	9.99342	9.24410	10.75590	10.00658	10.76249	3
58	9.23824	9.99340	9.24484	10.75516	10.00660	10.76177	2
59	9.23895	9.99337	9.24558	10.75442	10.00663	10.76105	1
60	9.23967	9.99335	9.24632	10.75368	10.00665	10.76033	0
		Sine.		Tang.		Secant.	Min.

80 *Degrees.*

A Table of Artificial Sines,

10 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.23967	9.99335	9.24632	10.75368	10.00665	10.76033	60
1	9.24039	9.99333	9.24706	10.75294	10.00667	10.75961	59
2	9.24110	9.99331	9.24779	10.75221	10.00669	10.75890	58
3	9.24181	9.99328	9.24853	10.75147	10.00672	10.75819	57
4	9.24253	9.99326	9.24926	10.75074	10.00674	10.75747	56
5	9.24324	9.99324	9.25000	10.75000	10.00676	10.75676	55
6	9.24395	9.99322	9.25073	10.74927	10.00678	10.75605	54
7	9.24466	9.99320	9.25146	10.74854	10.00681	10.75534	53
8	9.24536	9.99317	9.25219	10.74781	10.00683	10.75464	52
9	9.24607	9.99315	9.25292	10.74708	10.00685	10.75393	51
10	9.24678	9.99313	9.25365	10.74635	10.00687	10.75323	50
11	9.24748	9.99310	9.25437	10.74563	10.00690	10.75252	49
12	9.24818	9.99308	9.25510	10.74490	10.00692	10.75182	48
13	9.24888	9.99306	9.25582	10.74418	10.00694	10.75112	47
14	9.24958	9.99304	9.25655	10.74345	10.00696	10.75042	46
15	9.25028	9.99301	9.26727	10.74273	10.00699	10.74972	45
16	9.25098	9.99299	9.25799	10.74201	10.00701	10.74902	44
17	9.25168	9.99297	9.25871	10.74129	10.00703	10.74832	43
18	9.25237	9.99294	9.25943	10.74057	10.00706	10.74763	42
19	9.25307	9.99292	9.26015	10.73985	10.00708	10.74693	41
20	9.25376	9.99290	9.26086	10.73914	10.00710	10.74624	40
21	9.25445	9.99288	9.26158	10.73842	10.00713	10.74555	39
22	9.25514	9.99285	9.26229	10.73771	10.00715	10.74486	38
23	9.25583	9.99283	9.26301	10.73700	10.00717	10.74417	37
24	9.25652	9.99281	9.26372	10.73628	10.00719	10.74348	36
25	9.25721	9.99278	9.26443	10.73557	10.00722	10.74279	35
26	9.25790	9.99276	9.26514	10.73486	10.00724	10.74210	34
27	9.25858	9.99274	9.26585	10.73415	10.00726	10.74142	33
28	9.25927	9.99271	9.26656	10.73345	10.00729	10.74073	32
29	9.25995	9.99270	9.26726	10.73274	10.00731	10.74005	31
30	9.26063	9.99267	9.26797	10.73203	10.00733	10.73937	30
		Sine.		Tang.		Secant.	Min.

79 *Degrees.*

Tangents and Secants.

10 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.26063	9.99267	9.26797	10.73203	10.00733	10.73937	30
31	9.26131	9.99264	9.26867	10.73133	10.00736	10.73869	29
32	9.26199	9.99262	9.26938	10.73063	10.00738	10.73801	28
33	9.26267	9.99260	9.27008	10.72992	10.00740	10.73733	27
34	9.26335	9.99257	9.27078	10.72922	10.00743	10.73665	26
35	9.26403	9.99255	9.27148	10.72852	10.00745	10.73597	25
36	9.26470	9.99253	9.27218	10.72782	10.00748	10.73530	24
37	9.26538	9.99250	9.27288	10.72712	10.00750	10.73462	23
38	9.26605	9.99248	9.27357	10.72643	10.00752	10.73395	22
39	9.26672	9.99245	9.27427	10.72573	10.00755	10.73328	21
40	9.26739	9.99243	9.27496	10.72504	10.00757	10.73261	20
41	9.26807	9.99241	9.27566	10.72434	10.00759	10.73194	19
42	9.26873	9.99238	9.27635	10.72365	10.00762	10.73127	18
43	9.26940	9.99236	9.27704	10.72296	10.00764	10.73060	17
44	9.27007	9.99234	9.27773	10.72227	10.00767	10.72993	16
45	9.27074	9.99231	9.27842	10.72158	10.00769	10.72927	15
46	9.27140	9.99229	9.27911	10.72089	10.00771	10.72860	14
47	9.27206	9.99226	9.27980	10.72020	10.00774	10.72794	13
48	9.27273	9.99224	9.28049	10.71951	10.00776	10.72727	12
49	9.27339	9.99221	9.28117	10.71883	10.00779	10.72661	11
50	9.27405	9.99219	9.28186	10.71814	10.00781	10.72595	10
51	9.27471	9.99217	9.28254	10.71746	10.00783	10.72529	9
52	9.27537	9.99214	9.28323	10.71678	10.00786	10.72463	8
53	9.27602	9.99212	9.28391	10.71609	10.00788	10.72398	7
54	9.27668	9.99209	9.28459	10.71541	10.00791	10.72332	6
55	9.27734	9.99207	9.28527	10.71473	10.00793	10.72266	5
56	9.27799	9.99204	9.28595	10.71405	10.00796	10.72201	4
57	9.27864	9.99202	9.28662	10.71338	10.00798	10.72136	3
58	9.27930	9.99200	9.28739	10.71270	10.00800	10.72070	2
59	9.27995	9.99197	9.28798	10.71202	10.00803	10.72005	1
60	9.28060	9.99195	9.28865	10.71135	10.00805	10.71940	0
		Sine.		Tang.		Secant.	Min.

79 *Degrees.*

A Table of Artificial Sines,

11 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.28060	9.99195	9.18865	10.71135	10.00805	10.71940	60
1	9.28125	9.99192	9.28924	10.71067	10.00808	10.71875	59
2	9.28190	9.99190	9.29000	10.71000	10.00810	10.71810	58
3	9.28254	9.99187	9.29067	10.70933	10.00813	10.71746	57
4	9.28319	9.99185	9.29134	10.70866	10.00815	10.71681	56
5	9.28384	9.99182	9.29201	10.70799	10.00818	10.71616	55
6	9.28448	9.99180	9.29268	10.70732	10.00820	10.71552	54
7	9.28512	9.99177	9.29335	10.70665	10.00823	10.71488	53
8	9.28577	9.99175	9.29402	10.70598	10.00825	10.71423	52
9	9.28641	9.99172	9.29468	10.70532	10.00828	10.71359	51
10	9.28705	9.99170	9.29535	10.70465	10.00830	10.71295	50
11	9.28769	9.99167	9.29601	10.70399	10.00833	10.71231	49
12	9.28833	9.99165	9.29668	10.70332	10.00835	10.71167	48
13	9.28896	9.99162	9.29734	10.70266	10.00838	10.71104	47
14	9.28960	9.99160	9.29800	10.70200	10.00840	10.71040	46
15	9.29024	9.99157	9.29866	10.70134	10.00843	10.70976	45
16	9.29087	9.99155	9.29932	10.70068	10.00845	10.70913	44
17	9.29150	9.99152	9.29998	10.70002	10.00848	10.70850	43
18	9.29214	9.99150	9.30064	10.69936	10.00850	10.70786	42
19	9.29277	9.99147	9.30130	10.69871	10.00853	10.70723	41
20	9.29340	9.99145	9.30195	10.69805	10.00855	10.70660	40
21	9.29403	9.99142	9.30261	10.69739	10.00858	10.70597	39
22	9.29466	9.99140	9.30326	10.69674	10.00860	10.70534	38
23	9.29529	9.99137	9.30391	10.69609	10.00863	10.70471	37
24	9.29591	9.99135	9.30457	10.69543	10.00865	10.70409	36
25	9.29654	9.99132	9.30522	10.69478	10.00868	10.70346	35
26	9.29716	9.99130	9.30587	10.69413	10.00871	10.70284	34
27	9.29779	9.99127	9.30652	10.69348	10.00873	10.70221	33
28	9.29841	9.99124	9.30717	10.69283	10.00876	10.70159	32
29	9.29903	9.99122	9.30782	10.69218	10.00878	10.70097	31
30	9.29966	9.99119	9.30846	10.69154	10.00881	10.70035	30
		Sine.		Tang.		Secant.	Min.

78 *Degrees.*

11 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.29966	9.99119	9.30846	10.69154	10.00881	10.70035	30
31	9.30028	9.99117	9.30911	10.69089	10.00883	10.69972	29
32	9.30090	9.99114	9.30975	10.69025	10.00886	10.69611	28
33	9.30151	9.99112	9.31040	10.68960	10,00889	10.69849	27
34	9.30213	9.99109	9.31104	10.68896	10.00891	10.69787	26
35	9.30275	9.99106	9.31169	10.68832	10.00894	10.69725	25
36	9.30336	9.99104	9.31233	10.68767	10.00896	10.69664	24
37	9.30398	9.99101	9.31297	10.68703	10.00899	10.69602	23
38	9.30459	9.99099	9.31361	10.68639	10.00901	10.69541	22
39	9.30521	9.99096	9.31425	10.68575	10.00904	10.69479	21
40	9.30582	9.99093	9.31489	10.68512	10.00907	10.69418	20
41	9.30643	9.99091	9.31552	10.68448	10.00909	10.69357	19
42	9.30704	9.99088	9.31616	10.68384	10.00912	10.69296	18
43	9.30765	9.99086	9.31680	10.68321	10.00915	10.69235	17
44	9.30826	9.99083	9.31743	10.68257	10.00917	10.69174	16
45	9.30887	9.99080	9.31806	10.68194	10.00920	10.69113	15
46	9.30947	9.99078	9.31870	10.68130	10.00922	10.69053	14
47	9.31008	9.99075	9.31933	10.68067	10.00925	10.68992	13
48	9.31069	9.99072	9.31996	10.68004	10.00928	10.68932	12
49	9.31129	9.99070	9.32059	10.67941	10.00930	10.68871	11
50	9.31189	9.99067	9.32122	10.67878	10.00933	10.68811	10
51	9.31250	9.99064	9.32185	10.67815	10.00936	10.68751	9
52	9.31310	9.99062	9.32248	10.67752	10.00938	10.68690	8
53	9.31370	9.99059	9.32311	10.67689	10.00941	10.68630	7
54	9.31430	9.99057	9.32373	10.67627	10.00944	10.68570	6
55	9.31490	9.99054	9.32436	10.67564	10.00946	10.68510	5
56	9.31550	9.99051	9.32498	10.67502	10.00949	10.68451	4
57	9.31609	9.99049	9.32561	10.67439	10.00952	10.68391	3
58	9.31669	9.99046	9.32623	10.67377	10.00954	10.68331	2
59	9.31728	9.99043	9.32685	10.67315	10.00957	10.68272	1
60	9.31788	9.99040	9.32747	10.67253	10.00960	10.68212	0
		Sine.		Tang.		Secant.	Min.

78 *Degrees.*

A Table of Artificial Sines,

12 *Degrees.*

Min.	Sine.		Tang		Secant.		
0	9.31788	9.99046	9.32747	10.67253	10.00960	10.68212	60
1	9.31847	9.99038	9.32810	10.67191	10.00962	10.68153	59
2	9.31907	9.99035	9.22872	10.67129	10.00965	10.68093	58
3	9.31966	9.99032	9.32933	10.67067	10.00968	10.68034	57
4	9.32025	9.99030	9.32995	10.67005	10.00970	10.67974	56
5	9.32084	9.99027	9.33057	10.66994	10.00973	10.67916	55
6	9.32143	9.99024	9.33119	10.66881	10.00976	10.67857	54
7	9.32202	9.99022	9.33180	10.66820	10.00978	10.67798	53
8	9.32261	9.99019	9.33242	10.66758	10.00981	10.67739	52
9	9.32319	9.99016	9.33303	10.66697	10.00984	10.67681	51
10	9.32378	9.99013	9.33365	10.66635	10.00987	10.67622	50
11	9.32437	9.99011	9.33426	10.66574	10.00989	10.67563	49
12	9.32495	9.99008	9.33487	10.66513	10.00992	10.67505	48
13	9.32553	9.99005	9.33548	10.66452	10.00995	10.67447	47
14	9.32612	9.99003	9.33609	10.66391	10.00998	10.67388	46
15	9.32670	9.99000	9.33670	10.66330	10.01000	10.67330	45
16	9.32728	9.98997	9.33731	10.66269	10.01003	10.67272	44
17	9.32786	9.98994	9.33792	10.66208	10.01006	10.67214	43
18	9.32844	9.48992	9.33853	10.66147	10.01009	10.67156	42
19	9.32902	9.98989	9.33913	10.66087	10.01011	10.67098	41
20	9.32960	9.98986	9.33974	10.66026	10.01014	10.67040	40
21	9.33018	9.98983	9.34034	10.65966	10.01017	10.66982	39
22	9.33075	9.98980	9.34095	10.65905	10.01020	10.66925	38
23	9.33133	9.98978	9.34155	10.65845	10.01022	10.66867	37
24	9.33190	9.98975	9.34216	10.65785	10.01025	10.66810	36
25	9.33248	9.98972	9.34276	10.65724	10.01028	10.66752	35
26	9.33305	9.98969	9.34336	10.65664	10.01031	10.66695	34
27	9.33362	9.98967	9.34396	10.65604	10.01034	10.66638	33
28	9.33420	9.98964	9.34456	10.65544	10.01036	10.66580	32
29	9.33477	9.98961	9.34516	10.65484	10.01039	10.66523	31
30	9.33534	9.98958	9.34576	10.65425	10.01042	10.66466	30
		Sine.		Tang.		Secant.	Min.

77 *Degrees.*

A Table of Artificial Sines,

13 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.35209	9.98872	9.36336	10.63664	10.01128	10.64791	60
1	9.35264	9.98869	9.36394	10.63606	10.01131	10.64737	59
2	9.35318	9.98867	9.36452	10.63548	10.01133	10.64682	58
3	9.35373	9.98864	9.36509	10.63491	10.01136	10.64627	57
4	9.35427	9.98861	9.36566	10.63434	10.01139	10.64573	56
5	9.35482	9.98858	9.36624	10.63376	10.01142	10.64519	55
6	9.35536	9.98855	9.36681	10.63319	10.01145	10.64464	54
7	9.35590	9.98852	9.36738	10.63262	10.01148	10.64410	53
8	9.35644	9.98849	9.36795	10.63205	10.01151	10.64356	52
9	9.35698	9.98846	9.36852	10.63148	10.01154	10.64302	51
10	9.35752	9.98843	9.36909	10.63091	10.01157	10.64248	50
11	9.35806	9.98840	9.36966	10.63034	10.01160	10.64194	49
12	9.35860	9.98837	9.37023	10.62977	10.01163	10.64140	48
13	9.35914	9.98834	9.37080	10.62920	10.01166	10.64086	47
14	9.35968	9.98831	9.37137	10.62863	10.01169	10.64032	46
15	9.36022	9.98828	9.37193	10.62807	10.01172	10.63979	45
16	9.36075	9.98825	9.37250	10.62750	10.01175	10.63925	44
17	9.36129	9.98822	9.37306	10.62694	10.01178	10.63871	43
18	9.36182	9.98819	9.37363	10.62637	10.01181	10.63818	42
19	9.36236	9.98816	9.37419	10.62581	10.01184	10.63764	41
20	9.36289	9.98813	9.37476	10.62524	10.01187	10.63711	40
21	9.36342	9.98810	9.37532	10.62468	10.01190	10.63658	39
22	9.36395	9.98807	9.37588	10.62412	10.01193	10.63605	38
23	9.36449	9.98804	9.37644	10.62356	10.01196	10.63552	37
24	9.36502	9.98801	9.37700	10.62300	10.01199	10.63498	36
25	9.36555	6.98798	9.37756	10.62244	10.01202	10.63445	35
26	9.36608	9.98795	9.37812	10.62188	10.01205	10.63393	34
27	9.36660	9.98792	9.37868	10.62132	10.01208	10.63340	33
28	9.36713	9.98789	9.37924	10.62076	10.01211	10.63287	32
29	9.36766	9.98786	9.37980	10.62020	10.01214	10.63234	31
30	9.36819	9.98783	9.38035	10.61965	10.01217	10.63182	30
		Sine.		Tang.		Secant.	Min.

76 *Degrees.*

Tangents and Secants.

13 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.36819	9.98783	9.38035	10.61965	10.01217	10.63182	30
31	9.36871	9.98780	9.38091	10.61909	10.01220	10.63129	29
32	9.36924	9.98777	9.38147	10.61853	10.01223	10.63076	28
33	9.36976	9.98774	9.38202	10.61798	10.01226	10.63024	27
34	9.37029	9.98771	9.38258	10.61743	10.01229	10.62972	26
35	9.37081	9.98768	9.38313	10.61687	10.01232	10.62919	25
36	9.37133	9.98765	9.38368	10.61632	10.01235	10.62867	24
37	9.37185	9.98762	9.38423	10.61577	10.01238	10.62815	23
38	9.37237	9.98759	9.38479	10.61521	10.01241	10.62763	22
39	9.37289	9.98756	9.38534	10.61466	10.01244	10.62711	21
40	9.37341	9.98753	9.38589	10.61411	10.01247	10.62659	20
41	9.37393	9.98750	9.38644	10.61356	10.01250	10.62607	19
42	9.37445	9.98747	9.38699	10.61301	10.01254	10.62555	18
43	9.37497	9.98743	9.38754	10.61246	10.01257	10.62503	17
44	9.37549	9.98740	9.38808	10.61192	10.01260	10.62451	16
45	9.37600	9.98737	9.38863	10.61137	10.01263	10.62400	15
46	9.37652	9.98734	9.38918	10.61082	10.01266	10.62348	14
47	9.37704	9.98731	9.38972	10.61028	10.01269	10.62297	13
48	9.37755	9.98728	9.39027	10.60973	10.01272	10.62245	12
49	9.37806	9.98725	9.39082	10.60919	10.01275	10.62194	11
50	9.37858	9.98722	9.39136	10.60864	10.01278	10.62142	10
51	9.37909	9.98719	9.39190	10.60810	10.01281	10.62091	9
52	9.37960	9.98716	9.39245	10.60755	10.01285	10.62040	8
53	9.38011	9.98712	9.39299	10.60701	10.01288	10.61989	7
54	9.38062	9.98709	9.39353	10.60645	10.01291	10.61938	6
55	9.38113	9.98706	9.39407	10.60593	10.01294	10.61887	5
56	9.38164	9.98703	9.39461	10.60539	10.01297	10.61836	4
57	9.38216	9.98700	9.39515	10.60485	10.01300	10.61785	3
58	9.38266	9.98697	9.39569	10.60431	10.01303	10.61734	2
59	9.38317	9.98694	9.39623	10.60377	10.01306	10.61683	1
60	9.38368	9.98690	9.39677	10.60323	10.01310	10.61633	0
		Sine.		Tang.		Secant.	Min.

76 *Degrees.*

A Table of Artificial Sines,

15 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.41300	9.98494	9.42805	10.57195	10.01506	10.58700	60
1	9.41347	9.98491	9.42856	10.57144	10.01509	10.58653	59
2	9.41394	9.98488	9.42906	10.57094	10.01512	10.58606	58
3	9.41441	9.98484	9.42957	10.57043	10.01516	10.58559	57
4	9.41488	9.98481	9.43007	10.56993	10.01519	10.58512	56
5	9.41535	9.98477	9.43057	10.56943	10.01523	10.58465	55
6	9.41582	9.98474	9.43108	10.56893	10.01526	10.58419	54
7	9.41628	9.98471	9.43158	10.56842	10.01529	10.58372	53
8	9.41675	9.98467	9.43208	10.56792	10.01533	10.58325	52
9	9.41722	9.98464	9.43258	10.56742	10.01536	10.58278	51
10	9.41768	9.98460	9.43308	10.56692	10.01540	10.58232	50
11	9.41815	9.98457	9.43358	10.56642	10.01543	10.58185	49
12	9.41862	9.98454	9.43408	10.56592	10.01547	10.58139	48
13	9.41908	9.98450	9.43458	10.56542	10.01550	10.58092	47
14	9.41954	9.98447	9.43508	10.56492	10.01553	10.58046	46
15	9.42001	9.98443	9.43558	10.56442	10.01557	10.57999	45
16	9.42047	9.98440	9.43607	10.56393	10.01560	10.57953	44
17	9.42093	9.98436	9.43657	10.56343	10.01564	10.57907	43
18	9.42140	9.98433	9.43707	10.56293	10.01567	10.57861	42
19	9.42186	9.98429	9.43756	10.56244	10.01571	10.57814	41
20	9.42232	9.98426	9.43806	10.56194	10.01574	10.57768	40
21	9.42278	9.98422	9.43855	10.56145	10.01578	10.57722	39
22	9.42324	9.98419	9.43905	10.56095	10.01581	10.57676	38
23	9.42370	9.98416	9.43954	10.56046	10.01585	10.57630	37
24	9.42416	9.98412	9.44004	10.55996	10.01588	10.57584	36
25	9.42462	9.98409	9.44053	10.55947	10.01592	10.57539	35
26	9.42507	9.98405	9.44102	10.55898	10.01595	10.57493	34
27	9.42553	9.98402	9.44151	10.55849	10.01599	10.57447	33
28	9.42599	9.98398	9.44201	10.55799	10.01602	10.57401	32
29	9.42644	9.98395	9.44250	10.55750	10.01605	10.57356	31
30	9.42690	9.98391	9.44299	10.55701	10.01609	10.57310	30
		Sine.		Tang.		Secant.	Min.

74 *Degrees.*

15 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.42690	9.98391	9.44299	10.55701	10.01609	10.57310	30
31	9.42735	9.98388	9.44348	10.55652	10.01612	10.57265	29
32	9.42781	9.98384	9.44397	10.55603	10.01616	10.57219	28
33	9.42826	9.98381	9.44446	10.55554	10.01620	10.57174	27
34	9.42872	9.98377	9.44495	10.55505	10.01623	10.5712	26
35	9.42917	9.98374	9.44544	10.55457	10.01627	10.57083	25
36	9.42962	9.98370	9.44592	10.55408	10.01630	10.57038	24
37	9.43008	9.98366	9.44641	10.55359	10.01634	10.56993	23
38	9.43053	9.98363	9.44690	10.55310	10.01637	10.56947	22
39	9.43098	9.98359	9.44738	10.55262	10.01641	10.56902	21
40	9.43143	9.98356	9.44787	10.55213	10.01644	10.56857	20
41	9.43188	9.98352	9.44836	10.55164	10.01648	10.56812	19
42	9.43233	9.98349	9.44884	10.55116	10.01651	10.56767	18
43	9.43278	9.98345	9.44933	10.55067	10.01655	10.56722	17
44	9.43323	9.98342	9.44981	10.55019	10.01658	10.56677	16
45	9.43368	9.98338	9.45029	10.54971	10.01662	10.56633	15
46	9.43412	9.98335	9.45078	10.54922	10.01666	10.56588	14
47	9.43457	9.98331	9.45126	10.54874	10.01669	10.56543	13
48	9.43502	9.98327	9.45174	10.54826	10.01672	10.56498	12
49	9.43546	9.98324	9.45223	10.54778	10.01676	10.56454	11
50	9.43591	9.98320	9.45271	10.54729	10.01680	10.56409	10
51	9.43635	9.98317	9.45319	10.54681	10.01683	10.56365	9
52	9.43680	9.98313	9.45367	10.54633	10 61987	10.56320	8
53	9.43724	9.98309	9.45415	10.54585	10.01691	10.56276	7
54	9.43769	9.98306	9.45463	10.54537	10.01694	10.56231	6
55	9.43813	9.98302	9.45511	10.54489	10.01698	10.56187	5
56	9.43857	9.98299	9.45559	10.54441	10.01701	10.56143	4
57	9.43901	9.98295	9.45606	10.54394	10.01705	10.56099	3
58	9.43946	9.98291	9.45654	10.54346	10.01709	10.56054	2
59	9.43990	9.98288	9.45702	10.54298	10.01712	10.56010	1
60	9.44034	9.98284	9.45750	10.54250	10.01716	10.55966	0
		Sine.		Tang.		Secant.	Min.

74 *Degrees.*

A Table of Artificial Sines,

16 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.44034	9.98284	9.45750	10.54250	10.01716	10.55966	60
1	9.44078	9.98281	9.45797	10.54203	10.01720	10.55922	59
2	9.44122	9.98277	9.45845	10.54155	10.01723	10.55878	58
3	9.44166	9.98273	9.45893	10.54108	10.01727	10.55834	57
4	9.44210	9.98270	9.45940	10.54060	10.01730	10.55790	56
5	9.44254	9.98266	9.45988	10.54013	10.01734	10.55747	55
6	9.44297	9.98262	9.46035	10.53965	10.01738	10.55703	54
7	9.44341	9.98259	9.46082	10.53918	10.01741	10.55659	53
8	9.44385	9.98255	9.46130	10.53870	10.01745	10.55615	52
9	9.44428	9.98251	9.46177	10.53823	10.01749	10.55572	51
10	9.44472	9.98248	9.46224	10.53776	10.01752	10.55528	50
11	9.44516	9.98244	9.46271	10.53729	10.01756	10.55485	49
12	9.44559	9.98240	9.46319	10.53681	10.01760	10.55441	48
13	9.44603	9.98237	9.46366	10.53634	10.01763	10.55398	47
14	9.44646	9.98233	9.46413	10.53587	10.01767	10.55354	46
15	9.44689	9.98229	9.46460	10.53540	10.01771	10.55311	45
16	9.44733	9.98226	9.46507	10.53493	10.01774	10.55267	44
17	9.44776	9.98222	9.46554	10.53446	10.01778	10.55224	43
18	9.44819	9.98218	9.46601	10.53399	10.01782	10.55181	42
19	9.44862	9.98215	9.46648	10.53352	10.01785	10.55138	41
20	9.44905	9.98211	9.46695	10.53306	10.01789	10.55095	40
21	9.44949	9.98207	9.46741	10.53259	10.01793	10.55052	39
22	9.44992	9.98204	9.46788	10.53212	10.01797	10.55009	38
23	9.45035	9.98200	9.46835	10.53165	10.01800	10.54966	37
24	9.45078	9.98196	9.46881	10.53119	10.01804	10.54923	36
25	9.45120	9.98192	9.46928	10.53072	10.01808	10.54880	35
26	9.45163	9.93189	9.46975	10.53025	10.01811	10.54837	34
27	9.45206	9.98185	9.47021	10.52979	10.01815	10.54794	33
28	9.45249	9.98181	9.47068	10.52932	10.01819	10.54751	32
29	9.45292	9.98177	9.47114	10.52886	10.01823	10.54709	31
30	9.45334	9.98174	9.47161	10.52840	10.01826	10.54666	30
		Sine.		Tang.		Secant.	Min.

73 *Degrees.*

Tangents and Secants.

16 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.45334	9.98174	9.47161	10.52840	10.01826	10.54666	30
31	9.45377	9.98170	9.47207	10.52793	10.01830	10.54623	29
32	9.45419	9.98166	9.47253	10.52747	10.01834	10.54581	28
33	9.45462	9.98162	9.47300	10.52701	10.01838	10.54538	27
34	9.45504	9.98159	9.47346	10.52654	10.01841	10.54496	26
35	9.45547	9.98155	9.47392	10.52608	10.01845	10.54453	25
36	9.45589	9.98151	9.47438	10.52562	10.01849	10.54411	24
37	9.45632	9.98147	9.47484	10.52516	10.01853	10.54368	23
38	9.45674	9.98144	9.47530	10.52470	10.01856	10.54326	22
39	9.45716	9.98140	9.47576	10.52424	10.01860	10.54284	21
40	9.45758	9.98136	9.47622	10.52378	10.01864	10.54242	20
41	9.45801	9.98132	9.47668	10.52332	10.01868	10.54199	19
42	9.45843	9.98129	9.47714	10.52286	10.01872	10.54157	18
43	9.45885	9.98125	9.47760	10.52240	10.01875	10.54115	17
44	9.45927	9.98121	9.47806	10.52194	10.01879	10.54073	16
45	9.45969	9.98117	9.47852	10.52148	10.01883	10.54031	15
46	9.46011	9.98113	9.47898	10.52103	10.01887	10.53989	14
47	9.46053	9.98110	9.47943	10.52057	10.01891	10.53947	13
48	9.46095	9.98106	9.47989	10.52011	10.01894	10.53905	12
49	9.46136	9.98102	9.48035	10.51966	10.01898	10.53864	11
50	9.46178	9.98098	9.48080	10.51920	10.01902	10.53822	10
51	9.46220	9.98094	9.48126	10.51874	10.01906	10.53780	9
52	9.46266	9.98090	9.48171	10.51829	10.01910	10.53738	8
53	9.46303	9.98087	9.48217	10.51783	10.01913	10.53697	7
54	9.46345	9.98093	9.48262	10.51738	10.01917	10.53655	6
55	9.46386	9.98079	9.48308	10.51693	10.01921	10.53614	5
56	9.46428	9.98075	9.48353	10.51647	10.01925	10.53572	4
57	9.46469	9.98071	9.48398	10.51602	10.01929	10.53531	3
58	9.46511	9.98067	9.48444	10.51557	10.01933	10.53489	2
59	9.46555	9.98064	9.48489	10.51511	10.01937	10.53448	1
60	9.46594	9.98060	9.48534	10.51466	10.01940	10.53407	0
		Sine.		Tang.		Secant.	Min.

73 *Degrees.*

A Table of Artificial Sines,

17 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.46594	9.98060	9.48534	10.51466	10.01940	10.53407	60
1	9.46635	9.98056	9.48579	10.51421	10.01944	10.53365	59
2	9.46676	9.98052	9.48624	10.51376	10.01948	10.53324	58
3	9.46717	9.98048	9.48669	10.51331	10.01952	10.53283	57
4	9.46759	9.98044	9.48714	10.51286	10.01956	10.53242	56
5	9.46800	9.98040	9.48759	10.51241	10.01960	10.53200	55
6	9.46841	9.98036	9.48804	10.51196	10.01964	10.53159	54
7	9.46882	9.98033	9.48849	10.51151	10.01968	10.53118	53
8	9.46923	9.98029	9.48894	10.51106	10.01971	10.53077	52
9	9.46964	9.98025	9.48939	10.51061	10.01975	10.53036	51
10	9.47004	9.98021	9.48984	10.51016	10.01979	10.53995	50
11	9.47046	9.98017	9.49029	10.50971	10.01983	10.53955	49
12	9.47086	9.98013	9.49073	10.50927	10.01987	10.52914	48
13	9.47127	9.98009	9.49118	10.50882	10.01991	10.52873	47
14	9.47168	9.98005	9.49163	10.50837	10.01995	10.52823	46
15	9.47209	9.98001	9.49207	10.50793	10.01999	10.52791	45
16	9.47249	9.97997	9.49252	10.50748	10.02003	10.52751	44
17	9.47290	9.97993	9.49297	10.50704	10.02007	10.52710	43
18	9.47330	9.97990	9.49341	10.50659	10.02011	10.52670	42
19	9.47371	9.97986	9.49385	10.50615	10.02015	10.52629	41
20	9.47412	9.97982	9.49430	10.50570	10.02018	10.52589	40
21	9.47452	9.97978	9.49474	10.50526	10.02022	10.52548	39
22	9.47492	9.97974	9.49519	10.50481	10.02026	10.52508	38
23	9.47533	9.97970	9.49563	10.50437	10.02030	10.52467	37
24	9.47573	9.97966	9.49607	10.50393	10.02034	10.52427	36
25	9.47613	9.97962	9.49652	10.50349	10.02038	10.52387	35
26	9.47654	9.97958	9.49696	10.50304	10.02042	10.52346	34
27	9.47694	9.97954	9.49740	10.50260	10.02046	10.52306	33
28	9.47734	9.97950	9.49784	10.50216	10.02050	10.52266	32
29	9.47774	9.97946	9.49828	10.50172	10.02054	10.52226	31
30	9.47814	9.97942	9.49872	10.50128	10.02058	10.52186	30
		Sine.		Tang.		Secant.	Min.

72 *Degrees.*

A Table of Artificial Sines,

18 *Degrees.*

Min.	Sine.		Tang		Secant.		
0	9.48998	9.97821	9.51178	10.48822	10.02179	10.51002	60
1	9.49037	9.97817	9.51221	10.48779	10.02184	10.50963	59
2	9.49076	9.97814	9.51264	10.48737	10.02188	10.50924	58
3	9.49115	9.97808	9.51306	10.48640	10.02192	10.50885	57
4	9.49153	9.97804	9.51349	10.48651	10.02196	10.50847	56
5	9.49192	9.97800	9.51392	10.48608	10.02200	10.50807	55
6	9.49231	9.97796	9.51435	10.48565	10.02204	10.50769	54
7	9.49270	9.97792	9.51478	10.48522	10.02208	10.50731	53
8	9.49308	9.97788	9.51520	10.48480	10.02212	10.50692	52
9	9.49347	9.97784	9.51563	10.48437	10.02217	10.50653	51
10	9.49385	9.97779	9.51606	10.48394	10.02221	10.50615	50
11	9.49424	9.97775	9.51648	10.48352	10.02225	10.50576	49
12	9.49462	9.97771	9.51691	10.48309	10.02229	10.50538	48
13	9.49501	9.97767	9.51734	10.48267	10.02233	10.50500	47
14	9.49539	9.97763	9.51776	10.48224	10.02237	10.50461	46
15	9.49577	9.97759	9.51819	10.48181	10.02241	10.50423	45
16	9.49615	9.97754	9.51861	10.48139	10.02246	10.50385	44
17	9.49654	9.97750	9.51903	10.48097	10.02250	10.50346	43
18	9.49692	9.97746	9.51946	10.48054	10.02254	10.50308	42
19	9.49730	9.97742	9.51988	10.48012	10.02258	10.50270	41
20	9.49768	9.97738	9.52031	10.47970	10.02262	10.50232	40
21	9.49806	9.97734	9.52073	10.47927	10.02267	10.50194	39
22	9.49844	9.97729	9.52115	10.47885	10.02271	10.50156	38
23	9.49882	9.97725	9.52157	10.47843	10.02275	10.50118	37
24	9.49920	9.97721	9.52200	10 47801	10.02279	10.50080	36
25	9.49958	9.97717	9.52242	10.47758	10.02283	10.50042	35
26	9.49996	9.97713	9.52284	10.47716	10.02288	10.50004	34
27	9.50034	9.97708	9.52326	10.47674	10.02292	10.49966	33
28	9.50072	9.97704	9.52368	10.47632	10.02296	10.49928	32
29	9.50110	9.97700	9.52410	10.47590	10.02300	10.49890	31
30	9.50158	9.97696	9.52452	10.47548	10.02304	10.49852	30
		Sine.		Tang.		Secant.	Min.

71 *Degrees.*

Tangents and Secants.

18 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.50148	9.97696	9.52452	10.47548	10.02304	10.49852	30
31	9.50185	9.97691	9.52494	10.47506	10.02309	10.49815	29
32	9.50223	9.97687	9.52536	10.47464	10.02313	10.49777	28
33	9.50261	9.97683	9.52578	10.47422	10.02317	10.49739	27
34	9.50298	9.97679	9.52620	10.47380	10.02321	10.49702	26
35	9.50336	9.97675	9.52662	10.47339	10.02326	10.49664	25
36	9.50374	9.97670	9.52703	10.47297	10.02330	10.49627	24
37	9.50411	9.97666	9.52745	10.47255	10.02334	10.49589	23
38	9.50449	9.97662	9.52787	10.47213	10.02338	10.49552	22
39	9.50486	9.97657	9.52829	10.47172	10.02343	10.49514	21
40	9.50523	9.97653	9.52870	10.47130	10.02347	10.49477	20
41	9.50561	9.97649	9.52912	10.47088	10.02351	10.49439	19
42	9.50598	9.97645	9.52954	10.47047	10.02355	10.49402	18
43	9.50635	9.97640	9.52096	10.47005	10.02360	10.49365	17
44	9.50673	9.97636	9.53037	10.46963	10.02364	10.49327	16
45	9.50710	9.97632	9.53078	10.46922	10.02368	10.49290	15
46	9.50747	9.97628	9.53120	10.46880	10.02373	10.49253	14
47	9.50784	9.97623	9.53161	10.46839	10.02377	10.49216	13
48	9.50821	9.97619	9.53203	10.46798	10.02381	10.49179	12
49	9.50859	9.97615	9.53244	10.46756	10.02385	10.49142	11
50	9.50896	9.97610	9.53285	10.46715	10.02390	10.49104	10
51	9.50933	9.97606	9.53327	10.46673	10.02394	10.49067	9
52	9.50970	9.97602	9.53368	10.46632	10.02398	10.49030	8
53	9.51007	9.97597	9.53409	10.46591	10.02403	10.48994	7
54	9.51043	9.97593	9.53450	10.46550	10.02407	10.48957	6
55	9.51080	9.97589	9.53492	10.46508	10.02411	10.48920	5
56	9.51117	9.97584	9.53533	10.46467	10.02416	10.48883	4
57	9.51154	9.97580	9.53574	10.46426	10.02420	10.48846	3
58	9.51191	9.97576	9.53615	10.46385	10.02424	10.48809	2
59	9.51228	9.97571	9.53656	10.46344	10.02429	10.48773	1
60	9.51264	9.97567	9.53698	10.46302	10.02433	10.48736	0
		Sine.		Tang.		Secant.	Min.

71 *Degrees.*

A Table of Artificial Sines,

19 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.51264	9.97567	9.53697	10.46303	10.02433	10.48736	60
1	9.51301	9.97563	9.53738	10.46262	10.02437	10.48699	59
2	9.51338	9.97558	9.53779	10.46221	10.02442	10.48663	58
3	9.51374	9.97554	9.53820	10.46180	10.02446	10.48626	57
4	9.51411	9.97550	9.53861	10.46139	10.02450	10.48589	56
5	9.51447	9.97545	9.53902	10.46098	10.02455	10.48553	55
6	9.51484	9.97541	9.53943	10.46057	10.02459	10.48516	54
7	9.51520	9.97537	9.53984	10.46016	10.02464	10.48480	53
8	9.51557	9.97532	9.54025	10.45976	10.02468	10.48443	52
9	9.51593	9.97528	9.54065	10.45935	10.02472	10.48407	51
10	9.51629	9.97523	9.54106	10.45894	10.02477	10.48371	50
11	9.51666	9.97519	9.54147	10.45853	10.02481	10.48334	49
12	9.51702	9.97515	9.54188	10.45813	10.02486	10.48298	48
13	9.51738	9.97510	9.54228	10.45772	10.02490	10.48262	47
14	9.51775	9.97506	9.54269	10.45731	10.02494	10.48226	46
15	9.51811	9.97501	9.54309	10.45691	10.02499	10.48189	45
16	9.51847	9.97497	9.54350	10.45650	10.02503	10.48153	44
17	9.51883	9.97493	9.54391	10.45610	10.02508	10.48117	43
18	9.51919	9.97488	9.54431	10.45569	10.02512	10.48081	42
19	9.51955	9.97484	9.54472	10.45528	10.02516	10.48045	41
20	9.51991	9.97479	9.54312	10.45488	10.02521	10.48009	40
21	9.52027	9.97475	9.54552	10.45448	10.02525	10.47073	39
22	9.52063	9.97470	9.54593	10.45407	10.02530	10.47937	38
23	9.52099	9.97466	9.54633	10.45367	10.02534	10.47901	37
24	9.52135	9.97461	9.54673	10.45327	10.02539	10.47865	36
25	9.52171	9.97457	9.54714	10.45286	10.02543	10.47829	35
26	9.52207	9.97453	9.54754	10.45246	10.02548	10.47793	34
27	9.52242	9.97448	9.54794	10.45206	10.02551	10.47758	33
28	9.52278	9.97444	9.54835	10.45166	10.02556	10.47722	32
29	9.52314	9.97439	9.54875	10.45125	10.02561	10.47686	31
30	9.52350	9.97435	9.54915	10.45085	10.02565	10.47651	30
		Sine.		Tang.		Secant.	Min.

70 *Degrees.*

19 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.52350	9.97435	9.54915	10.45085	10.02565	10.47651	30
31	9.52385	9.97430	9.54955	10.45045	10.02570	10.47615	29
32	9.52421	9.97426	9.54995	10.45005	10.02574	10.47579	28
33	9.52456	9.97421	9.55035	10.4496:	10.02579	10.47544	27
34	9.52492	9.97417	9.55075	10.44925	10.02583	10.47508	26
35	9.52528	9.97412	9.55115	10.44885	10.02587	10.47473	25
36	9.52563	9.97408	9.55155	10.44845	10.02592	10.47437	24
37	9.52598	9.97403	9.55195	10.44805	10.02597	10.47402	23
38	9.52634	9.97399	9.55235	10.44765	10.02601	10.47366	22
39	9.52669	9.97394	9.55275	10.44725	10.02606	10.47331	21
40	9.52705	9.97390	9.55315	10.44685	10.02610	10.47295	20
41	9.52740	9.97385	9.55355	10.44645	10.02615	10.47260	19
42	9.52775	9.97381	9.55395	10.44605	10.02619	10.47225	18
43	9.52811	9.97376	9.55434	10.44566	10.02624	10.47190	17
44	9.52846	9.97372	9.55474	10.44526	10.02628	10.47154	16
45	9.52881	9.97367	9.55514	10.44486	10.02633	10.47119	15
46	9.52916	9.97363	9.55554	10.44446	10.02637	10.47084	14
47	9.52951	9.97358	9.55593	10.44407	10.02642	10.47049	13
48	9.52986	9.97354	9.55633	10.44367	10.02647	10,47014	12
49	9.53022	9.97349	9.55673	10.44327	10.02651	10.46979	11
50	9.53057	9.97344	9.55712	10.44288	10.02656	10.46944	10
51	9.53092	9.97340	9.55752	10.44248	10.02660	10.46909	9
52	9.53127	9.97335	9.55791	10.44209	10.02665	10.46874	8
53	9.53161	9.97331	9.55831	10.44169	10.02669	10.46839	7
54	9.53196	9.97326	9.55870	10.44130	10.02674	10.46804	6
55	9.53231	9.97322	9.55910	10.44090	10.02679	10.46769	5
56	9.53266	9.97317	9.55949	10.44051	10.02683	10.46734	4
57	9.53301	9.97312	9.55989	10.44012	10.02688	10.46699	3
58	9.53336	9.97308	9.56028	10.43972	10.02692	10.46664	2
59	9.53370	9.97303	9.56067	10.43933	10.02697	10.46630	1
60	9.53405	9.97299	9.56107	10.43893	10.02701	10.46595	0
		Sine.		Tang.		Secant.	Min.

70 *Degrees.*

Tangents and Secants.

20 Degrees.

Min.	Sine.		Tang.		Secant.		
30	9.54433	9.97159	9.57274	10.42726	10.02841	10.45568	30
31	9.54466	9.97154	9.57312	10.42688	10.02846	10.45534	29
32	9.54500	9.97149	9.57351	10.42649	10.02851	10.45500	28
33	9.54534	9.97145	9.57389	10.42611	10.02855	10.45466	27
34	9.54567	9.97140	9.57428	10.42572	10.02860	10.45433	26
35	9.54601	9.97135	9.57466	10.42534	10.02865	10.45399	25
36	9.54635	9.97130	9.57504	10.42496	10.02870	10.45365	24
37	9.54668	9.97126	9.57543	10.42457	10.02874	10.45332	23
38	9.54702	9.97121	9.57581	10.42419	10.02879	10.45298	22
39	9.54735	9.97116	9.57619	10.42381	10.02884	10.45265	21
40	9.54769	9.97111	9.57658	10.42342	10.02889	10.45231	20
41	9.54802	9.97107	9.57696	10.42304	10.02893	10.45198	19
42	9.54836	9.97102	9.57734	10.42266	10.02898	10.45164	18
43	9.54869	9.97097	9.57772	10.42228	10.02903	10.45131	17
44	9.54903	9.97092	9.57810	10.42190	10.02908	10.45097	16
45	9.54936	9.97087	9.57849	10.42151	10.02913	10.45064	15
46	9.54969	9.97083	9.57887	10.42113	10.02917	10.45031	14
47	9.55003	9.97078	9.57925	10.42075	10.02922	10.44997	13
48	9.55036	9.97073	9.57963	10.42037	10.02927	10.44964	12
49	9.55069	9.97068	9.58001	10.41999	10.02932	10.44931	11
50	9.55102	9.97064	9.58039	10.41961	10.02937	10.44898	10
51	9.55136	9.97059	9.58077	10.41923	10.02941	10.44864	9
52	9.55169	9.97054	9.58115	10.41885	10.02946	10.44831	8
53	9.55202	9.97049	9.58153	10.41847	10.02951	10.44798	7
54	9.55235	9.97044	9.58191	10.41809	10.02956	10.44765	6
55	9.55268	9.97039	9.58229	10.41771	10.02961	10.44732	5
56	9.55301	9.97035	9.58267	10.41734	10.02966	10.44699	4
57	9.55334	9.97030	9.58304	10.41696	10.02970	10.44666	3
58	9.55367	9.97025	9.58342	10.41658	10.02975	10.44633	2
59	9.55400	9.97020	9.58380	10.41620	10.02980	10.44600	1
60	9.55433	9.97015	9.58418	10.41582	10.02985	10.44567	0
		Sine.		Tang.		Secant.	Min.

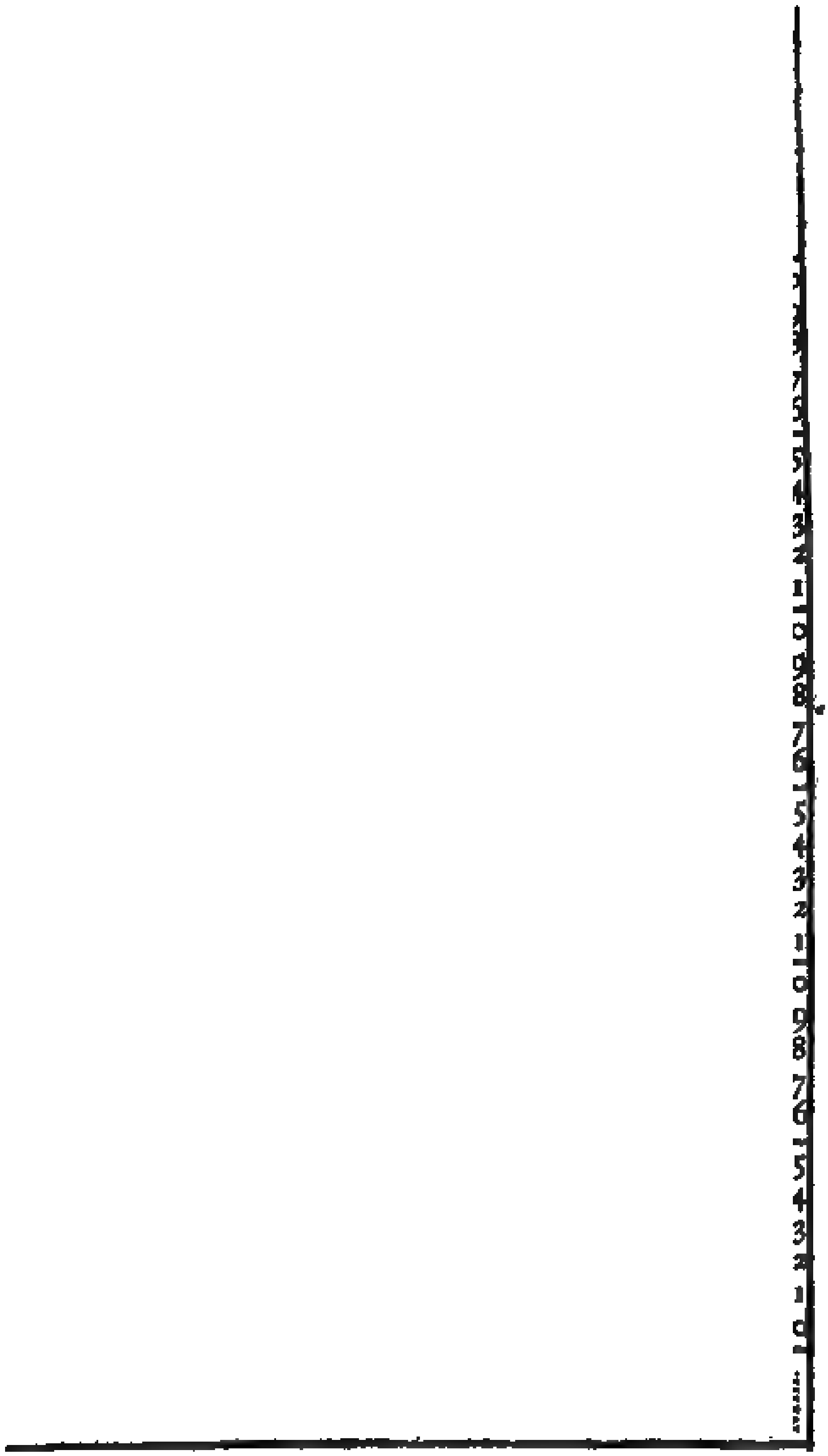
69 Degrees.

A Table of Artificial Sines,

21 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.55433	9.97015	9.58418	10.41582	10.02985	10.44567	60
1	9.55466	9.97010	9.58456	10.41545	10.02990	10.44534	59
2	9.55499	9.97006	9.58493	10.41507	10.02995	10.44501	58
3	9.55532	9.97001	9.58531	10.41469	10.02999	10.44468	57
4	9.55564	9.96996	9.58569	10.41431	10.03004	10 44436	56
5	9.55597	9.96991	9.58606	10.41394	10.03009	10.44401	55
6	9.55630	9.96986	9.58644	10.41356	10.03014	10.44370	54
7	9.55663	9.96981	9.58682	10.41319	10.03019	10.44337	53
8	9.55695	9.96976	9.58719	10.41281	10.03024	10.44305	52
9	9.55728	9.96971	9.58757	10.41243	10.03029	10.44272	51
10	9.55761	9.96967	9.58794	10.41206	10.03034	10.44239	50
11	9.55793	9.96962	9.58832	10.41168	10.03038	10.44207	49
12	9.55826	9.96957	9.58869	10.41131	10.03043	10.44174	48
13	9.55858	9.96952	9.58907	10.41093	10.03048	10.44142	47
14	9.55891	9.96947	9.58944	10.41056	10.03053	10.44109	46
15	9.55923	9.96942	9.58981	10.41019	10.03058	10.44076	45
16	9.55956	9.96937	9.59016	10.40981	10.03063	10.44044	44
17	9.55988	9.96932	9.59056	10.40944	10.03068	10.44012	43
18	9.56021	9.96927	9.59094	10.40907	10.03073	10.43979	42
19	9.56053	9.96922	9.59131	10.40869	10.03078	10.43947	41
20	9.56086	9.96917	9.59168	10.40832	10.03083	10.43915	40
21	9.56118	9,96912	9.59205	10.40795	10.03088	10.43882	39
22	9.56150	9.96908	9.59243	10.40757	10.03093	10.43850	38
23	9.56182	9.96903	9.59280	10.40720	10.03098	10.43818	37
24	9.56215	9.96898	9.59317	10.40683	10.03102	10.43785	36
25	9.56247	9.96893	9.59354	10.40646	10.03107	10.43753	35
26	9.56280	9.96888	9.59391	10.40609	10.03112	10.43721	34
27	9.56311	9.96883	9.59429	10.40572	10.03118	10.43689	33
28	9.56343	9.96878	9.59466	10.40534	10.03122	10.43657	32
29	9.56376	9.96873	9.59503	10.40497	10.03127	10.43625	31
30	9.56408	9.96868	9.59540	10.40460	10.03132	10.43592	30
		Sine.		Tang.		Secant.	Min.

68 *Degrees.*



A Table of Artificial Sines,

22 Degrees.

Min.	Sine.		Tang.		Secant.		
0	9.57358	9.96717	9.60641	10.39359	10.03283	10.42643	60
1	9.57389	9.96712	9.60677	10.39323	10.03289	10.42611	59
2	9.57420	9.96706	9.60714	10.39286	10.03294	10.42580	58
3	9.57451	9.96701	9.60750	10.39250	10.03299	10.42549	57
4	9.57482	9.96696	9.60786	10.39214	10.03304	10.42518	56
5	9.57514	9.96691	9.60823	10.39178	10.03309	10.42487	55
6	9.57545	9.96686	9.60859	10.39141	10.03314	10.42455	54
7	9.57576	9.96681	9.60895	10.39105	10.03319	10.42424	53
8	9.57607	9.96676	9.60931	10.39069	10.03324	10.42393	52
9	9.57638	9.96671	9.60967	10.39033	10.03330	10.42362	51
10	9.57669	9.96665	9.61004	10.38996	10.03335	10.42331	50
11	9.57700	9.96660	9.61040	10.38960	10.03340	10.42300	49
12	9.57731	9.96655	9.61076	10.38924	10.03345	10.42269	48
13	9.57762	9.96650	9.61112	10.38888	10.03350	10.42238	47
14	9.57793	9.96645	9.61148	10.38852	10.03355	10.42207	46
15	9.57824	9.96640	9.61184	10.38816	10.03361	10.42176	45
16	9.57855	9.96634	9.61200	10.38780	10.03366	10.42146	44
17	9.57885	9.96629	9.61256	10.38744	10.03371	10.42115	43
18	9.57916	9.96624	9.61292	10.38708	10.03376	10.42084	42
19	9.57947	9.96619	9.61328	10.38672	10.03381	10.42053	41
20	9.57978	9.96614	9.61[illegible]64	10.38636	10.03386	10.42023	40
21	9.58008	9.96609	9.61400	10.38600	10.03392	10.41992	39
22	9.58039	9.96603	9.61436	10.38564	10.03397	10.41961	38
23	9.58070	9.96598	9.61472	10.38528	10.03402	10.41930	37
24	9.58101	9.96593	9.61508	10.38492	10.03407	10.41900	36
25	9.58131	9.96588	9.61544	10.38457	10.03412	10.41869	35
26	9.58162	9.96582	9.61579	10.38421	10.03418	10.41838	34
27	9.58192	9.96577	9.61615	10.38385	10.03423	10.41808	33
28	9.58223	9.96572	9.61651	10.38349	10.03428	10.41777	32
29	9.58253	9.96567	9.61687	10.38313	10.03433	10.41747	31
30	9.58284	9.96562	9.61722	10.38278	10.03439	10.41716	30
		Sine.		Tang.		Secant.	Min.

67 Degrees.

22 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.58284	9.96562	9.61722	10.38278	10.03439	10.41716	30
31	9.58314	9.96556	9.61758	10.38242	10.03444	10.41686	29
32	9.58345	9.96551	9.61794	10.38206	10.03449	10.41655	28
33	9.58375	9.96546	9.61830	10.38171	10.03454	10.41625	27
34	9.58406	9.96541	9.61865	10.38135	10.03459	10.41594	26
35	9.58436	9.96535	9.61901	10.38099	10.03465	10.41564	25
36	9.58467	9.96530	9.61936	10.38064	10.03470	10.41534	24
37	9.58497	9.96525	9.61972	10.38028	10.03475	10.41503	23
38	9.58527	9.96520	9.62008	10.37992	10.03481	10.41473	22
39	9.58557	9.96514	9.62043	10.37957	10.03486	10.41443	21
40	9.58588	9.96509	9.62079	10.37921	10.03491	10.41412	20
41	9.58618	9.96504	9.62114	10.37886	10.03496	10.41382	19
42	9.58648	9.96498	9.62150	10.37850	10.03502	10.41352	18
43	9.58678	9.96493	9.62185	10.37815	10.03507	10.41322	17
44	9.58709	9.96488	9.62221	10.37779	10.03512	10.41292	16
45	9.58739	9.96483	9.62256	10.37744	10.03517	10.41261	15
46	9.58769	9.96477	9.62292	10.37709	10.03523	10.41231	14
47	9.58799	9.96472	9.62327	10.37673	10.03528	10.41201	13
48	9.58829	9.96467	9.62362	10.37638	10.03533	10.41171	12
49	9.58859	9.96461	9.62398	10.37602	10.03539	10.41141	11
50	9.58889	9.96456	9.62433	10.37567	10.03544	10.41111	10
51	9.58919	9.96451	9.62468	10.37532	10.03549	10.41081	9
52	9.58949	9.96445	9.62504	10.37496	10.03555	10.41051	8
53	9.58979	9.96440	9.62539	10.37461	10.03560	10.41021	7
54	9.59009	9.96435	9.62574	10.37426	10.03566	10.40991	6
55	9.59039	9.96429	9.62609	10.37391	10.03571	10.40961	5
56	9.59069	9.96424	9.62645	10.37356	10.03576	10.40931	4
57	9.59098	9.96419	9.62680	10.37320	10.03581	10.40902	3
58	9.59128	9.96413	9.62715	10.37285	10.03587	10.40872	2
59	9.59158	9.96408	9.62750	10.37250	10.03592	10.40842	1
60	9.59188	9.96403	9.62785	10.37215	10.03597	10.40812	0
		Sine.		Tang.		Secant.	Min.

67 *Degrees.*

O 2

A Table of Artificial Sines,

24 Degrees.

Min.	Sine.		Tang.		Secant.		
0	9.60931	9.96073	9.64858	10.35142	10.03927	10.39069	60
1	9.60960	9.96067	9.64892	10.35108	10.03933	10.39040	59
2	9.60988	9.96062	9.64926	10.35074	10.03938	10.39012	58
3	9.61016	9.96056	9.64960	10.35040	10.03944	10.38984	57
4	9.61045	9.96051	9.64994	10.35006	10.03950	10.38955	56
5	9.61073	9.96045	9.65028	10.34972	10.03955	10.38927	55
6	9.61101	9.96039	9.65062	10.34938	10.03961	10.38899	54
7	9.61129	9.96034	9.65096	10.34904	10.03967	10.38871	53
8	9.61158	9.96028	9.65130	10.34870	10.03972	10.38842	52
9	9.61186	9.96022	9.65164	10.34836	10.03978	10.38814	51
10	9.61214	9.96017	9.65197	10.34803	10.03983	10.38786	50
11	9.61242	9.96011	9.65231	10.34769	10.03989	10.38758	49
12	9.61270	9.96005	9.65265	10.34735	10.03995	10.38730	48
13	9.61298	9.96000	9.65299	10.34701	10.04001	10.38702	47
14	9.61326	9.95994	9.65333	10.34667	10.04006	10.38674	46
15	9.61355	9.95988	9.65366	10.34634	10.04012	10.38646	45
16	9.61383	9.95983	9.65400	10.34600	10.04018	10.38618	44
17	9.61411	9.95977	9.65434	10.34566	10.04023	10.38590	43
18	9.61439	9.95971	9.65467	10.34533	10.04029	10.38562	42
19	9.61467	9.95965	9.65501	10.34499	10.04035	10.38534	41
20	9.61494	9.95960	9.65535	10.34465	10.04040	10.38506	40
21	9.61522	9.95954	9.65568	10.34432	10.04046	10.38478	39
22	9.61550	9.95944	9.65602	10.34398	10.04052	10.38450	38
23	9.61578	9.95943	9.65636	10.34364	10.04058	10.38422	37
24	9.61606	9.95937	9.65669	10.34331	10.04063	10.38394	36
25	9.61634	9.95931	9.65703	10.34297	10.04069	10.38366	35
26	9.61662	9.95925	9.65736	10.34264	10.04075	10.38338	34
27	9.61689	9.95920	9.65770	10.34230	10.04081	10.38311	33
28	9.61717	9.95914	9.65803	10.34197	10.04086	10.38283	32
29	9.61745	9.95908	9.65837	10.34163	10.04092	10.38255	31
30	9.61773	9.95902	9.65870	10.34130	10.04098	10.38227	30
		Sine.		Tang.		Secant.	Min.

65 Degrees.

Tangents and Secants.

24 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.61773	9.95902	9.65870	10.34130	10.04098	10.38227	30
31	9.61800	9.95897	9.65904	10.34096	10.04104	10.38200	29
32	9.61828	9.95891	9.65937	10.34063	10.04109	10.38172	28
33	9.61856	9.95885	9.65971	10.34029	10.04115	10.38144	27
34	9.61883	9.95879	9.66004	10.33996	10.04121	10.38117	26
35	9.61911	9.95873	9.66038	10.33962	10.04127	10.38089	25
36	9.61939	9.95868	9.66071	10.33929	10.04132	10.38061	24
37	9.61966	9.95862	9.66104	10.33896	10.04138	10.38034	23
38	9.61994	9.95856	9.66138	10.33862	10.04144	10.38006	22
39	9.62021	9.95850	9.66171	10.33829	10.04150	10.37979	21
40	9.62049	9.95845	9.66204	10.33796	10.04156	10.37951	20
41	9.62076	9.95839	9.66238	10.33762	10.04161	10.37924	19
42	9.62104	9.95833	9.66271	10.33729	10.04167	10.37896	18
43	9.62131	9.95827	9.66304	10.33696	10.04173	10.37869	17
44	9.62159	9.95821	9.66337	10.33663	10.04179	10.37841	16
45	9.62186	9.95815	9.66371	10.33629	10.04185	10.37814	15
46	9.62214	9.95810	9.66404	10.33596	10.04190	10.37787	14
47	9.62241	9.95804	9.66437	10.33563	10.04196	10.37759	13
48	9.62268	9.95798	9.66470	10.33530	10.04202	10.37732	12
49	9.62296	9.95792	9.66504	10.33497	10.04208	10.37704	11
50	9.62323	9.95786	9.66537	10.33463	10.04214	10.37677	10
51	9.62350	9.95780	9.66570	10.33430	10.04220	10.37650	9
52	9.62377	9.95775	9.66603	10.33397	10.04225	10.37623	8
53	9.62405	9.95769	9.66636	10.33364	10.04231	10.37595	7
54	9.62432	9.95763	9.66669	10.33331	10.04237	10.37568	6
55	9.62459	9.95757	9.66702	10.33298	10.04243	10.37541	5
56	9.62486	9.95751	9.66735	10.33265	10.04249	10.37514	4
57	9.62514	9.95745	9.66768	10.33232	10.04255	10.37487	3
58	9.62541	9.95739	9.66801	10.33199	10.04261	10.37459	2
59	9.62568	9.95734	9.66834	10.33166	10.04267	10.37432	1
60	9.62595	9.95728	9.66867	10.33133	10.04272	10.37405	0
		Sine.		Tang.		Secant.	Min.

65 *Degrees.*

Tangents and Secants.

25 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.63398	9.95549	9.67850	10.32150	10.04451	10.36602	30
31	9.63425	9.95543	9.67882	10.32118	10.04457	10.36575	29
32	9.63451	9.95537	9.67915	10.32085	10.04463	10.36549	28
33	9.63478	9.95531	9.67947	10.32053	10.04469	10.36522	27
34	9.63504	9.95525	9.67980	10.32021	10.04475	10.36496	26
35	9.63531	9.95519	9.68012	10.31988	10.04481	10.36469	25
36	9.62567	9.95513	9.68044	10.31956	10.04487	10.36443	24
37	9.63583	9.95507	9.68077	10.31923	10.04494	10.36417	23
38	9.63610	9.95501	9.68109	10.31891	10.04500	10.36390	22
39	9.63636	9.95494	9.68142	10.31858	10.04506	10.36364	21
40	9.63662	9.95488	9.68174	10.31826	10.04512	10.36338	20
41	9.63689	9.95482	9.68206	10.31794	10.04518	10.36311	19
42	9.63715	9.95476	9.68239	10.31761	10.04524	10.36285	18
43	9.63741	9.95470	9.68271	10.31729	10.04530	10.36259	17
44	9.63767	9.95464	9.68303	10.31697	10.04536	10.36233	16
45	9.63794	9.95458	9.68336	10.31664	10.04542	10.36207	15
46	9.63820	9.95452	9.68368	10.31632	10.04548	10.36180	14
47	9.63846	9.95446	9.68400	10.31600	10.04554	10.36154	13
48	9.63872	9.95440	9.68432	10.31568	10.04560	10.36128	12
49	9.63898	9.95434	9.68465	10.31535	10.04567	10.36102	11
50	9.63924	9.95427	9.68497	10.31503	10.04573	10.36076	10
51	9.63950	9.95421	9.68529	10.31471	10.04579	10.36050	9
52	9.63976	9.95415	9.68561	10.31439	10.04585	10.36024	8
53	9.64002	9.95409	9.68593	10.31407	10.04591	10.35998	7
54	9.64028	9.95403	9.68626	10.31375	10.04597	10.35972	6
55	9.64054	9.95397	9.68658	10.31342	10.04603	10.35946	5
56	9.64080	9.95391	9.68690	10.31310	10.04609	10.35920	4
57	9.64106	9.95385	9.68722	10.31278	10.04016	10.35894	3
58	9.64132	9.95378	9.68754	10.31246	10.04622	10.35868	2
59	9.64158	9.95372	9.68786	10.31214	10.04628	10.35842	1
60	9.64184	9.95366	9.68818	10.31182	10.04634	10.35816	0
		Sine.		Tang.		Secant.	Min.

64 *Degrees.*

A Table of Artificial Sines,

26 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.64184	9.95366	9.68818	10.31182	10.04634	10.35816	60
1	9.64210	9.95360	9.68850	10.31150	10.04640	10.35790	59
2	9.64236	9.95354	9.68882	10.31118	10.04646	10.35764	58
3	9.64262	9.95348	9.68914	10.31086	10.04653	10.35738	57
4	9.64288	9.95341	9.68946	10.31054	10.04659	10.34712	56
5	9.64314	9.95335	9.68978	10.31022	10.04665	10.35687	55
6	9.64339	9.95329	9.69010	10.30990	10.04671	10.35661	54
7	9.64365	9.95323	9.69042	10.30958	10.04677	10.35635	53
8	9.64391	9.95317	9.69074	10.30926	10.04683	10.35609	52
9	9.64417	9.95310	9.69106	10.30894	10.04690	10.35584	51
10	9.64442	9.95304	9.69138	10.30862	10.04696	10.35558	50
11	9.64468	9.95298	9.69170	10.30830	10.04702	10.35532	49
12	9.64494	9.95292	9.69202	10.30798	10.04708	10.35506	48
13	9.64519	9.95286	9.69234	10.30766	10.04715	10.35481	47
14	9.64545	9.95279	9.69266	10.30734	10.04721	10.35455	46
15	9.64571	9.95273	9.69298	10.30703	10.04727	10.35429	45
16	9.64596	9.95267	9.69329	10.30671	10.04733	10.35404	44
17	9.64622	9.95261	9.69361	10.30639	10.04739	10.35378	43
18	9.64647	9.95254	9.69393	10.30607	10.04746	10.35353	42
19	9.64673	9.95248	9.69425	10.30575	10.04752	10.35327	41
20	9.64698	9.95242	9.69457	10.30543	10.04758	10.35302	40
21	9.64724	9.95236	9.69488	10.30512	10.04764	10.35276	39
22	9.64749	9.95229	9.69520	10.30480	10.04771	10.35251	38
23	9.64775	9.95223	9.69552	10.30448	10.04777	10.35225	37
24	9.64800	9.95217	9.69584	10.30416	10.04783	10.35200	36
25	9.64826	9.95211	9.69615	10.30385	10.04789	10.35174	35
26	9.64851	9.95204	9.69647	10.30353	10.04796	10.35149	34
27	9.64877	9.95198	9.69679	10.30321	10.04802	10.35123	33
28	9.64962	9.95192	9.69710	10.30290	10.04808	10.35098	32
29	9.64927	9.95185	9.69742	10.30258	10.04815	10.35073	31
30	9.64953	9.95179	9.69774	10.30226	10.04821	10.35047	30
		Sine.		Tang.		Secant.	Min.

63 *Degrees.*

P

A Table of Artificial Sines,

27 Degrees.

Min.	Sine.		Tang.		Secant.		
0	9.65705	9.94988	9.70717	10.29283	10.05012	10.34295	60
1	9.65730	9.94982	9.70748	10.29252	10.05018	10.34271	59
2	9.65754	9.94975	9.70779	10.29221	10.05025	10.34246	58
3	9.65779	9.94969	9.70810	10.29190	10.05031	10.34221	57
4	9.65804	9.94962	9.70841	10.29159	10.05038	10.34196	56
5	9.65828	9.94956	9.70873	10.29127	10.05044	10.34172	55
6	9.65853	9.94949	9.70904	10.29096	10.05051	10.34147	54
7	9.65878	9.94943	9.70935	10.29065	10.05057	10.34122	53
8	9.65903	9.94936	9.70966	10.29034	10.05064	10.34098	52
9	9.65927	9.94930	9.70997	10.29003	10.05070	10.34073	51
10	9.65952	9.94924	9.71028	10.28972	10.05077	10.34048	50
11	9.65976	9.94917	9.71059	10.28941	10.05083	10.34024	49
12	9.66001	9.94911	9.71090	10.28910	10.05090	10.33999	48
13	9.66026	9.94904	9.71122	10.28879	10.05096	10.33975	47
14	9.66050	9.94898	9.71153	10.28848	10.05103	10.33950	46
15	9.66075	9.94891	9.71184	10.28816	10.05109	10.33925	45
16	9.66099	9.94885	9.71215	10.28785	10.05116	10.33901	44
17	9.66124	9.94878	9.71246	10.28754	10.05122	10.33876	43
18	9.66148	9.94872	9.71277	10.28723	10.05129	10.33852	42
19	9.66173	9.94865	9.71308	10.28692	10.05135	10.33827	41
20	9.66197	9.94858	9.71339	10.28661	10.05142	10.33803	40
21	9.66221	9.94852	9.71370	10.28630	10.05148	10.33779	39
22	9.66246	9.94845	9.71401	10.28600	10.05155	10.33754	38
23	9.66270	9.94839	9.71431	10.28569	10.05161	10.33730	37
24	9.66295	9.94832	9.71462	10.28538	10.05168	10.33705	36
25	9.66319	9.94826	9.71493	10.28507	10.05174	10.33681	35
26	9.66343	9.94819	9.71524	10.28476	10.05181	10.33657	34
27	9.66368	9.94813	9.71555	10.28445	10.05187	10.33632	33
28	9.66392	9.94806	9.71586	10.28414	10.05194	10.33608	32
29	9.66416	9.94800	9.71617	10.28383	10.05201	10.33584	31
30	9.66441	9.94793	9.71648	10.28352	10.05207	10.33559	30
		Sine.		Tang.		Secant.	Min.

62 Degrees.

A Table of Artificial Sines,

29 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.68557	9.94182	9.74375	10.25625	10.05818	10.31443	60
1	9.68580	9.94175	9.74405	10.25595	10.05825	10.31420	59
2	9.68603	9.94168	9.74435	10.25565	10.05832	10.31397	58
3	9.68625	9.94161	9.74465	10.25536	10.05839	10.31375	57
4	9.68648	9.94154	9.74494	10.25506	10.05846	10.31352	56
5	9.68671	9.94147	9.74524	10.25476	10.05853	10.31329	55
6	9.68694	9.94140	9.74554	10.25446	10.05860	10.31306	54
7	9.68716	9.94133	9.74584	10.25417	10.05867	10.31284	53
8	9.68739	9.94126	9.74613	10.25387	10.05874	10.31261	52
9	9.68762	9.94119	9.74643	10.25357	10.05881	10.31238	51
10	9.68784	9.94112	9.74673	10.25327	10.05888	10.31216	50
11	9.68807	9.94105	9.74702	10.25298	10.05895	10.31193	49
12	9.68830	9.94098	9.74732	10.25268	10.05902	10.31171	48
13	9.68852	9.94091	9.74762	10.25238	10.05910	10.31148	47
14	9.68875	9.94083	9.74791	10.25209	10.05917	10.31125	46
15	9.68897	9.94076	9.74821	10.25179	10.05924	10.31103	45
16	9.68920	9.94069	9.74851	10.25150	10.05931	10.31080	44
17	9.68942	9.94062	9.74880	10.25120	10.05938	10.31058	43
18	9.68965	9.94055	9.74910	10.25090	10.05945	10.31035	42
19	9.68987	9.94048	9.74939	10.25061	10.05952	10.31013	41
20	9.69010	9.94041	9.74969	10.25031	10.05959	10.30990	40
21	9.69032	9.94034	9.74997	10.25002	10.05966	10.30968	39
22	9.69055	9.94027	9.75028	10.24972	10.05973	10.30945	38
23	9.69077	9.94020	9.75058	10.24942	10.05980	10.30923	37
24	9.69100	9.94013	9.75087	10.24913	10.05988	10.30900	36
25	9.69122	9.94005	9.75117	10.24883	10.05995	10.30878	35
26	9.69144	9.93998	9.75146	10.24854	10.06002	10.30856	34
27	9.69167	9.93991	9.75176	10.24824	10.06009	10.30833	33
28	9.69190	9.93984	9.75205	10.24795	10.06016	10.30811	32
29	9.69212	9.93977	9.75235	10.24765	10.06023	10.30788	31
30	9.69234	9.93970	9.75264	10.24736	10.06030	10.30766	30
		Sine.		Tang.		Secant.	Min.

60 *Degrees.*

A Table of Artificial Sines,

31 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.71184	9.93307	9.77877	10.22123	10.06693	10.28816	60
1	9.71205	9.93299	9.77906	10.22094	10.06701	10.28795	59
2	9.71226	9.93291	9.77935	10.22065	10.06709	10.28774	58
3	9.71247	9.93284	9.77963	10.22037	10.06716	10.28753	57
4	9.71268	9.93276	9.77992	10.22008	10.06727	10.28732	56
5	9.71289	9.93269	9.78020	10.21980	10.06732	10.28711	55
6	9.71310	9.93261	9.78049	10.21951	10.06739	10.28690	54
7	9.71331	9.93253	9.78078	10.21923	10.06747	10.28669	53
8	9.71352	9.93246	9.78106	10.21894	10.06754	10.28648	52
9	9.71373	9.93238	9.78135	10.21865	10.06762	10.28627	51
10	9.71394	9.93230	9.78163	10.21837	10.06770	10.28607	50
11	9.71414	9.93223	9.78192	10.21808	10.06777	10.28586	49
12	9.71435	9.93215	9.78220	10.21780	10.06785	10.28565	48
13	9.71456	9.93208	9.78249	10.21751	10.06793	10.28544	47
14	9.71477	9.93200	9.78277	10.21723	10.06800	10.28523	46
15	9.71498	9.93192	9.78306	10.21695	10.06808	10.28502	45
16	9.71519	9.93185	9.78334	10.21666	10.06816	10.28481	44
17	9.71539	9.93177	9.78363	10.21637	10.06823	10.28461	43
18	9.71560	9.93169	9.78391	10.21609	10.06831	10.28440	42
19	9.71581	9.93161	9.78419	10.21581	10.06839	10.28419	41
20	9.71602	9.93154	9.78448	10.21552	10.06846	10.28398	40
21	9.71622	9.93146	9.78479	10.21524	10.06854	10.28378	39
22	9.71643	9.93138	9.78505	10.21495	10.06862	10.28357	38
23	9.71663	9.93131	9.78533	10.21467	10.06869	10.28336	37
24	9.71685	9.93123	9.78562	10.21438	10.06877	10.28315	36
25	9.71705	9.93115	9.78590	10.21410	10.06885	10.28295	35
26	9.71726	9.93108	9.78618	10.21382	10.06893	10.28274	34
27	9.71747	9.93100	9.78647	10.21353	10.06900	10.28253	33
28	9.71767	9.93092	9.78675	10.21325	10.06908	10.28233	32
29	9.71788	9.93084	9.78704	10.21296	10.06916	10.28212	31
30	9.71809	9.93077	9.78732	10.21268	10.06923	10.28192	30
		Sine.		Tang.		Secant.	Min.

58 *Degrees.*

A Table of Artificial Sines,

32 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.72421	9.92842	9.79579	10.20421	10.07158	10.27579	60
1	9.72441	9.92834	9.79607	10.20393	10.07166	10.27559	59
2	9.72461	9.92826	9.79635	10.20365	10.07174	10.27539	58
3	9.72482	9.92818	9.79663	10.20337	10.07182	10.27518	57
4	9.72502	9.92810	9.79691	10.20309	10.07190	10.27498	56
5	9.72522	9.92803	9.79719	10.20281	10.07198	10.27478	55
6	9.72542	9.92795	9.79747	10.20253	10.07205	10.27458	54
7	9.72562	9.92787	9.79776	10.20225	10.07213	10.27438	53
8	9.72582	9.92779	9.79804	10.20196	10.07221	10.27418	52
9	9.72602	9.92770	9.79832	10.20168	10.07229	10.27398	51
10	9.72623	9.92763	9.79860	10.20140	10.07237	10.27378	50
11	9.72643	9.92755	9.79888	10.20112	10.07245	10.27357	49
12	9.72663	9.92747	9.79916	10.20084	10.07253	10.27337	48
13	9.72683	9.92739	9.79944	10.20056	10.07261	10.27317	47
14	9.72703	9.92731	9.79972	10.20028	10.07269	10.27297	46
15	9.72723	9.92723	9.80000	10.20000	10.07277	10.27277	45
16	9.72743	9.92715	9.80028	10.19972	10.07285	10.27257	44
17	9.72763	9.92707	9.80056	10.19944	10.07293	10.27237	43
18	9.72783	9.92699	9.80084	10.19916	10.07301	10.27217	42
19	9.72803	9.92691	9.80112	10.19888	10.07309	10.27197	41
20	9.72823	9.92683	9.80140	10.19860	10.07317	10.27177	40
21	9.72843	9.92675	9.80168	10.19833	10.07325	10.27157	39
22	9.72863	9.92667	9.80196	10.19805	10.07333	10.27137	38
23	9.72883	9.92659	9.80223	10.19777	10.07341	10.27118	37
24	9.72902	9.92651	9.80251	10.19749	10.07349	10.27098	36
25	9.72922	9.92643	9.80279	10.19721	10.07357	10.27078	35
26	9.72942	9.92635	9.80307	10.19693	10.07365	10.27058	34
27	9.72962	9.92627	9.80335	10.19665	10.07373	10.27033	33
28	9.72982	9.92619	9.80363	10.19637	10.07381	10.27018	32
29	9.73002	9.92611	9.80391	10.19609	10.07389	10.26998	31
30	9.73022	9.92603	9.80419	10.19581	10.07397	10.26978	30
		Sine.		Tang.		Secant.	Min.

57 *Degrees.*

A Table of Artificial Sines,

33 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.73610	9.92359	9.81252	10.18748	10.07641	10.26389	60
1	9.73630	9.92351	9.81279	10.18721	10.07649	10.26370	59
2	9.73650	9.92343	9.81307	10.18693	10.07657	10.26350	58
3	9.73669	9.92335	9.81335	10.18665	10.07666	10.26331	57
4	9.73689	9.92326	9.81362	10.18638	10.07674	10.26311	56
5	9.73708	9.92318	9.81390	10.18610	10.07682	10.26292	55
6	9.73727	9.92310	9.81418	10.18582	10.07690	10.26273	54
7	9.73747	9.92302	9.81445	10.18555	10.07698	10.26253	53
8	9.73766	9.92293	9.81473	10.18527	10.07706	10.26234	52
9	9.73786	9.92285	9.81500	10.18500	10.07715	10.26215	51
10	9.73805	9.92277	9.81528	10.18472	10.07723	10.26195	50
11	9.73824	9.92269	9.81556	10.18445	10.07731	10.26176	49
12	9.73843	9.92260	9.81583	10.18417	10.07740	10.26157	48
13	9.73863	9.92252	9.81611	10.18389	10.07748	10.26137	47
14	9.73882	9.92244	9.81638	10.18362	10.07756	10.26118	46
15	9.73901	9.92236	9.81666	10.18334	10.07765	10.26099	45
16	9.73921	9.92227	9.81693	10.18307	10.07773	10.26079	44
17	9.73940	9.92219	9.81721	10.18279	10.07781	10.26060	43
18	9.73959	9.92211	9.81748	10.18252	10.07789	10.26041	42
19	9.73978	9.92202	9.81776	10.18224	10.07798	10.26022	41
20	9.73998	9.92194	9.81804	10.18197	10.07806	10.26003	40
21	9.74017	9.92186	9.81831	10.18169	10.07814	10.25983	39
22	9.74036	9.92177	9.81859	10.18142	10.07823	10.25964	38
23	9.74057	9.92169	9.81886	10.18114	10.07831	10.25945	37
24	9.74074	9.92161	9.81913	10.18087	10.07839	10.25926	36
25	9.74093	9.92152	9.81941	10.18059	10.07848	10.25907	35
26	9.74113	9.92144	9.81968	10.18032	10.07856	10.25888	34
27	9.74132	9.92136	9.81996	10.18004	10.07864	10.25868	33
28	9.74151	9.92127	9.82023	10.17977	10.07873	10.25849	32
29	9.74170	9.92119	9.82051	10.17949	10.07881	10.25830	31
30	9.74189	9.92111	9.82078	10.17922	10.07889	10.25811	30
		Sine.		Tang.		Secant.	Min.

56 *Degrees.*

34 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.75313	9.91599	9.83713	10.16287	10.08401	10.24687	30
31	9.75331	9.91591	9.83741	10.16260	10.08409	10.24669	29
32	9.75350	9.91582	9.83768	10.16232	10.08418	10.24651	28
33	9.75368	9.91573	9.83795	10.16205	10.08427	10.24632	27
34	9.75386	9.91565	9.83822	10.16178	10.08435	10.24614	26
35	9.75405	9.91556	9.83849	10.16151	10.08444	10.24595	25
36	9.75423	9.91547	9.83876	10.16124	10.08453	10.24577	24
37	9.75441	9.91539	9.83903	10.16097	10.08462	10.24559	23
38	9.75460	9.91530	9.83930	10.16070	10.08470	10.24541	22
39	9.75478	9.91521	9.83957	10.16043	10.08479	10.24522	21
40	9.75496	9.91512	9.83984	10.16016	10.08488	10.24504	20
41	9.75514	9.91504	9.84011	10.15989	10.08497	10.24486	19
42	9.75533	9.91495	9.84038	10.15962	10.08505	10.24467	18
43	9.75551	9.91486	9.84065	10.15935	10.08514	10.24449	17
44	9.75569	9.91477	9.84092	10.15908	10.08523	10.24431	16
45	9.75587	9.91469	9.84119	10.15881	10.08532	10.24413	15
46	9.75605	9.91460	9.84146	10.15854	10.08540	10.24394	14
47	9.75624	9.91451	9.84173	10.15827	10.08549	10.24376	13
48	9.75642	9.91442	9.84200	10.15800	10.08558	10.24358	12
49	9.75660	9.91433	9.84227	10.15773	10.08567	10.24340	11
50	9.75678	9.91425	9.84254	10.15747	10.08575	10.24322	10
51	9.75696	9.91416	9.84281	10.15720	10.08584	10.24304	9
52	9.75714	9.91407	9.84307	10.15693	10.08593	10.24286	8
53	9.75733	9.91398	9.84334	10.15666	10.08602	10.24267	7
54	9.75751	9.91389	9.84361	10.15639	10.08611	10.24249	6
55	9.75769	9.91381	9.84388	10.15612	10.08619	10.24231	5
56	9.75787	9.91372	9.84415	10.15585	10.08628	10.24213	4
57	9.75805	9.91363	9.84442	10.15558	10.08637	10.24195	3
58	9.75823	9.91354	9.84469	10.15531	10.08646	10.24177	2
59	9.75841	9.91345	9.84496	10.15504	10.08655	10.24159	1
60	9.75859	9.91336	9.84523	10.15477	10.08664	10.24141	0
		Sine.		Tang.		Secant.	Min.

55 *Degrees.*

A Table of Artificial Sines,

35 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.75859	9.91336	9.84523	10.15477	10.08665	10.24141	60
1	9.75877	9.91328	9.84550	10.15450	10.08672	10.24123	59
2	9.75895	9.91319	9.84576	10.15424	10.08681	10.24105	58
3	9.75913	9.91310	9.84603	10.15397	10.08690	10.24087	57
4	9.75931	9.91301	9.84630	10.15370	10.08699	10.24069	56
5	9.75949	9.91292	9.84657	10.15343	10.08708	10.24051	55
6	9.75967	9.91283	9.84684	10.15316	10.08717	10.24033	54
7	9.75985	9.91274	9.84711	10.15289	10.08726	10.24015	53
8	9.76003	9.91266	9.84738	10.15262	10.08735	10.23997	52
9	9.76021	9.91257	9.84764	10.15236	10.08743	10.23979	51
10	9.76039	9.91248	9.84791	10.15209	10.08752	10.23961	50
11	9.76057	9.91239	9.84818	10.15182	10.08761	10.23943	49
12	9.76075	9.91230	9.84845	10.15155	10.08770	10.23925	48
13	9.76093	9.91221	9.84872	10.15128	10.08779	10.23907	47
14	9.76111	9.91212	9.84899	10.15101	10.08788	10.23889	46
15	9.76129	9.91203	9.84925	10.15075	10.08797	10.23871	45
16	9.76146	9.91194	9.84952	10.15048	10.08806	10.23854	44
17	9.76164	9.91185	9.84979	10.15021	10.08815	10.23836	43
18	9.76182	9.91176	9.85006	10.14994	10.08824	10.23818	42
19	9.76200	9.91167	9.85033	10.14968	10.08833	10.23800	41
20	9.76218	9.91158	9.85059	10.14941	10.08842	10.23782	40
21	9.76236	9.91150	9.85086	10.14914	10.08851	10.23764	39
22	9.76253	9.91141	9.85113	10.14887	10.08860	10.23747	38
23	9.76271	9.91132	9.85140	10.14860	10.08868	10.23729	37
24	9.76289	9.91123	9.85166	10.14834	10.08877	10.23711	36
25	9.76307	9.91114	9.85193	10.14807	10.08886	10.23693	35
26	9.76325	9.91105	9.85220	10.14780	10.08895	10.23676	34
27	9.76342	9.91096	9.85247	10.14753	10.08904	10.23658	33
28	9.76360	9.91087	9.85273	10.14727	10.08913	10.23640	32
29	9.76378	9.91078	9.85300	10.14700	10.08922	10.23622	31
30	9.76395	9.91069	9.85327	10.14673	10.08931	10.23605	30
		Sine.		Tang.		Secant.	Min.

54 *Degrees.*

A Table of Artificial Sines,

36 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.76922	9.90796	9.86126	10.13874	10.09204	10.23078	60
1	9.76939	9.90787	9.86153	10.13847	10.09213	10.23061	59
2	9.76957	9.90777	9.86179	10.13821	10.09223	10.23043	58
3	9.76974	9.90768	9.86206	10.13704	10.09232	10.23026	57
4	9.76991	9.90759	9.86232	10.13768	10.09241	10.23009	56
5	9.77009	9.90750	9.86259	10.13741	10.09250	10.22991	55
6	9.77026	9.90741	9.86285	10.13715	10.09259	10.22974	54
7	9.77043	9.90731	9.86312	10.13688	10.09269	10.22957	53
8	9.77061	9.90722	9.86339	10.13662	10.09278	10.22939	52
9	9.77078	9.90713	9.86365	10.13635	10.09287	10.22922	51
10	9.77095	9.90704	9.86392	10.13609	10.09296	10.22905	50
11	9.77113	9.90695	9.86418	10.13582	10.09306	10.22888	49
12	9.77130	9.90685	9.86445	10.13556	10.09315	10.22870	48
13	9.77147	9.90676	9.86471	10.13529	10.09324	10.22852	47
14	9.77164	9.90667	9.86498	10.13502	10.09333	10.22836	46
15	9.77182	9.90657	9.86524	10.13476	10.09343	10.22819	45
16	9.77199	9.90648	9.86551	10.13450	10.09352	10.22801	44
17	9.77216	9.90639	9.86577	10.13423	10.09361	10.22784	43
18	9.77233	9.90630	9.86604	10.13397	10.09370	10.22767	42
19	9.77250	9.90620	9.86630	10.13370	10.09380	10.22750	41
20	9.77268	9.90611	9.86656	10.13344	10.09389	10.22733	40
21	9.77285	9.90602	9.86683	10.13317	10.09398	10.22715	39
22	9.77302	9.90593	9.86709	10.13291	10.09408	10.22698	38
23	9.77319	9.90583	9.86736	10.13264	10.09417	10.22681	37
24	9.77336	9.90574	9.86762	10.13238	10.09426	10.22664	36
25	9.77353	9.90565	9.86789	10.13211	10.09436	10.22647	35
26	9.77370	9.90555	9.86815	10.13185	10.09445	10.22630	34
27	9.77388	9.90546	9.86842	10.13158	10.09454	10.22613	33
28	9.77405	9.90537	9.86868	10.13132	10.09463	10.22595	32
29	9.77422	9.90527	9.86895	10.13106	10.09473	10.22578	31
30	9.77439	9.90518	9.86921	10.13079	10.09482	10.22561	30
		Sine.		Tang.		Secant.	Min.

53 *Degrees.*

38 Degrees.

Min.	Sine.		Tang.		Secant.		
0	9.78934	9.89653	9.89381	10.10719	10.10347	10.21066	60
1	9.78950	9.89643	9.89307	10.10693	10.10357	10.21050	59
2	9.78967	9.89634	9.89333	10.10667	10.10367	10.21034	58
3	9.78983	9.89624	9.89359	10.10641	10.10376	10.21017	57
4	9.78999	9.89614	9.89385	10.10615	10.10386	10.21001	56
5	9.79015	9.89604	9.89411	10.10589	10.10396	10.20985	55
6	9.79031	9.89594	9.89437	10.10563	10.10406	10.20969	54
7	9.79047	9.89584	9.89463	10.10537	10.10416	10.20953	53
8	9.79063	9.89574	9.89489	10.10511	10.10426	10.20937	52
9	9.79079	9.89564	9.89515	10.10485	10.10436	10.20921	51
10	9.79095	9.89554	9.89541	10.10459	10.10446	10.20905	50
11	9.79112	9.89544	9.89567	10.10433	10.10456	10.20889	49
12	9.79128	9.89534	9.89593	10.10407	10.10466	10.20873	48
13	9.79144	9.89524	9.89619	10.10381	10.10476	10.20856	47
14	9.79160	9.89514	9.89645	10.10355	10.10486	10.20840	46
15	9.79176	9.89505	9.89671	10.10329	10.10496	10.20824	45
16	9.79192	9.89495	9.89697	10.10303	10.10506	10.20808	44
17	9.79208	9.89485	9.89723	10.10277	10.10515	10.20792	43
18	9.79224	9.89475	9.89749	10.10250	10.10525	10.20776	42
19	9.79240	9.89465	9.89775	10.10225	10.10535	10.20760	41
20	9.79256	9.89455	9.89801	10.10199	10.10545	10.20744	40
21	9.79272	9.89445	9.89827	10.10173	10.10555	10.20728	39
22	9.79288	9.89435	9.89853	10.10147	10.10565	10.20712	38
23	9.79304	9.89425	9.89879	10.10121	10.10575	10.20696	37
24	9.79320	9.89415	9.89905	10.10095	10.10585	10.20681	36
25	9.79335	9.89405	9.89931	10.10069	10.10595	10.20665	35
26	9.79351	9.89395	9.89957	10.10043	10.10605	10.20649	34
27	9.79367	9.89385	9.89983	10.10017	10.10615	10.20633	33
28	9.79383	9.89375	9.90009	10.09991	10.10626	10.20617	32
29	9.79399	9.89365	9.90035	10.09965	10.10636	10.20601	31
30	9.79415	9.89354	9.90061	10.09940	10.10646	10.20585	30
		Sine.		Tang.		Secant.	Min.

51 Degrees.

Tangents and Secants.

42 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.82968	9.86763	9.96205	10.03795	10.13237	10.17032	30
31	9.82982	9.86752	9.96231	10.03769	10.13249	10.17018	29
32	9.82996	9.86740	9.96256	10.03744	10.13260	10.17004	28
33	9.83010	9.86728	9.9628[illegible]	10.03719	10.13272	10.16990	27
34	9.83023	9.86717	9.96307	10.03693	10.13283	10.16977	26
35	9.83037	9.86705	9.96332	10.03668	10.13295	10.16963	25
36	9.83051	9.86694	9.96357	10.03643	10.13307	10.16949	24
37	9.83065	9.86682	9.96383	10.03617	10.13318	10.16935	23
38	9.83078	9.86670	9.96408	10.03592	10.13330	10.16922	22
39	9.83092	9.86659	9.96434	10.03567	10.13341	10.16908	21
40	9.83106	9.86647	9.96459	10.03541	10.13353	10.16894	20
41	9.83120	9.86635	9.96484	10.03516	10.13365	10.16881	19
42	9.83133	9.86624	9.96510	10.03491	10.13376	10.16867	18
43	9.83147	9.86612	9.96535	10.03465	10.13388	10.16853	17
44	9.83161	9.86600	9.96560	10.03440	10.13400	10.16839	16
45	9.83174	9.86589	9.96586	10.03414	10.13411	10.16826	15
46	9.83188	9.86577	9.96611	10.03389	10.13423	10.16812	14
47	9.83202	9.86565	9.96636	10.03364	10.13435	10.16798	13
48	9.83215	9.86554	9.96662	10.03338	10.13446	10.16785	12
49	9.83229	9.86542	9.96687	10.03313	10.13458	10.16771	11
50	9.83243	9.86530	9.96712	10.03288	10.13470	10.16758	10
51	9.83256	9.86519	9.96738	10.03262	10.13482	10.16744	9
52	9.83270	9.86507	9.96763	10.03237	10.13493	10.16730	8
53	9.83283	9.86495	9.96788	10.03212	10.13505	10.16717	7
54	9.83297	9.86483	9.96814	10.03186	10.13517	10.16703	6
55	9.83311	9.86472	9.96839	10.03161	10.13528	10.16690	5
56	9.83324	9.86460	9.96864	10.03136	10.13540	10.16676	4
57	9.83338	9.86448	9.96890	10.03110	10.13552	10.16662	3
58	9.83351	9.86436	9.96915	10.03085	10.13564	10.16649	2
59	9.83365	9.86425	9.96940	10.03060	10.13576	10.16635	1
60	9.83378	9.86413	9.96966	10.03034	10.13587	10.16622	0
		Sine.		Tang.		Secant.	Min.

47 *Degrees.*

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A Table of Artificial Sines,

44 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.84177	9.85693	9.98484	10.01516	10.14307	10.15823	60
1	9.84190	9.85681	9.98509	10.01491	10.14319	10.15810	59
2	9.84203	9.85669	9.98534	10.01466	10.14331	10.15797	58
3	9.84216	9.85657	9.98560	10.01440	10.14333	10.15784	57
4	9.84220	9.85645	9.98585	10.01415	10.14355	10.15771	56
5	9.84242	9.85632	9.98610	10.01390	10.14368	10.15750	55
6	9.84256	9.85620	9.98635	10.01365	10.14380	10.15745	54
7	9.84261	9.85608	9.98661	10.01339	10.14392	10.15732	53
8	9.84282	9.85596	9.98686	10.01314	10.14404	10.15719	52
9	9.84295	9.85583	9.98711	10.01289	10.14417	10.15705	51
10	9.84308	9.85571	9.98737	10.01264	10.14429	10.15692	50
11	9.84321	9.85559	9.98762	10.01238	10.14441	10.15679	49
12	9.84334	9.85547	9.98787	10.01213	10.14454	10.15666	48
13	9.84347	9.85534	9.98812	10.01188	10.14466	10.15653	47
14	9.84360	9.85522	9.98838	10.01162	10.14478	10.15641	46
15	9.84373	9.85510	9.98863	10.01137	10.14490	10.15628	45
16	9.84386	9.85497	9.98888	10.01112	10.14503	10.15615	44
17	9.84398	9.85485	9.98913	10.01087	10.14515	10.15602	43
18	9.84411	9.85473	9.98939	10.01061	10.14527	10.15589	42
19	9.84424	9.85460	9.98964	10.01036	10.14540	10.15576	41
20	9.84437	9.85448	9.98989	10.01011	10.14552	10.15563	40
21	9.84450	9.85436	9.99014	10.00986	10.14564	10.15550	39
22	9.84463	9.85423	9.99040	10.00960	10.14577	10.15537	38
23	9.84476	9.85411	9.99065	10.00935	10.14589	10.15524	37
24	9.84489	9.85399	9.99090	10.00910	10.14601	10.15511	36
25	9.84502	9.85386	9.99116	10.00884	10.14614	10.15498	35
26	9.84515	9.85374	9.99141	10.00859	10.14626	10.15485	34
27	9.84528	9.85361	9.99166	10.00834	10.14639	10.15472	33
28	9.84540	9.85349	9.99191	10.00809	10.14651	10.15460	32
29	9.84553	9.85337	9.99217	10.00783	10.14663	10.15447	31
30	9.84566	9.85324	9.99242	10.00758	10.14676	10.15434	30
		Sine.		Tang.		Secant.	Min.

45 *Degrees.*

Tangents and Secants.

44 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.84566	9.85324	9.99242	10.00758	10.14676	10.15434	30
31	9.84579	9.85312	9.99267	10.00733	10.14688	10.15421	29
32	9.84592	9.85299	9.99293	10.00708	10.14701	10.15408	28
33	9.84605	9.85287	9.99318	10.00682	10.14713	10.15395	27
34	9.84618	9.85275	9.99343	10.00657	10.14726	10.15383	26
35	9.84630	9.85262	9.99308	10.00632	10.14738	10.15370	25
36	9.84643	9.85250	9.99394	10.00606	10.14750	10.15357	24
37	9.84655	9.85237	9.99419	10.00581	10.14763	10.15344	23
38	9.84669	9.85225	9.99444	10.00556	10.14775	10.15331	22
39	9.84682	9.85212	9.99469	10.00531	10.14788	10.15318	21
40	9.84694	9.85200	9.99495	10.00505	10.14800	10.15306	20
41	9.84707	9.85187	9.99520	10.00480	10.14813	10.15293	19
42	9.84720	9.85175	9.99545	10.00455	10.14825	10.15280	18
43	9.84733	9.85162	9.99571	10.00430	10.14838	10.15267	17
44	9.84745	9.85150	9.99596	10.00404	10.14850	10.15255	16
45	9.84758	9.85137	9.99621	10.00379	10.14863	10.15242	15
46	9.84771	9.85125	9.99646	10.00354	10.14875	10.15229	14
47	9.84784	9.85112	9.99672	10.00329	10.14888	10.15216	13
48	9.84796	9.85100	9.99667	10.00303	10.14900	10.15204	12
49	9.84809	9.85087	9.99722	10.00278	10.14913	10.15191	11
50	9.84822	9.85075	9.99747	10.00253	10.14926	10.15178	10
51	9.84835	9.85062	9.99773	10.00227	10.14938	10.15166	9
52	9.84847	9.85049	9.99798	10.00202	10.14951	10.15153	8
53	9.84860	9.85037	9.99823	10.00177	10.14963	10.15140	7
54	9.84873	9.85024	9.99848	10.00152	10.14976	10.15127	6
55	9.84885	9.85012	9.99874	10.00126	10.14988	10.15115	5
56	9.84898	9.84999	9.99899	10.00101	10.15001	10.15102	4
57	9.84911	9.84986	9.99924	10.00076	10.15014	10.15089	3
58	9.84923	9.84974	9.99950	10.00051	10.15026	10.15077	2
59	9.84936	9.84961	9.99975	10.00025	10.15039	10.15064	1
60	9.84949	9.84949	10.000c	10.0000c	10.15052	10.15052	0
		Sine.		Tang.		Secant.	Min.

45 *Degrees.*

A TABLE *of the* Sun's *Declination for the Years*

Days.	Jan. S.		Feb. S.		March. S.		April. N.		May. N.		June. N.		Days.
	°	'	°	'	°	'	°	'	°	'	°	'	
1	21	37	13	36	03	12	08	47	18	12	23	12	1
2	21	27	13	16	02	49	09	08	18	27	23	15	2
3	21	16	12	56	02	25	09	30	18	42	23	18	3
4	21	05	12	35	02	01	09	51	18	56	23	21	4
5	20	54	12	14	01	37	10	13	19	10	23	23	5
6	20	42	11	53	01	14	10	34	19	23	23	25	6
7	20	30	11	32	00	50	10	55	19	37	23	27	7
8	20	17	11	11	00	26	11	16	19	50	23	28	8
9	20	04	10	49	00	03	11	37	20	03	23	29	9
10	19	51	10	27	N	21	11	57	20	15	23	29	10
11	19	37	10	05	00	44	12	17	20	27	23	29	11
12	19	23	09	42	01	08	12	37	20	38	23	28	12
13	19	09	09	21	01	32	12	57	20	49	23	27	13
14	18	54	08	59	01	55	13	16	21	00	23	26	14
15	18	39	08	37	02	19	13	36	21	11	23	24	15
16	18	24	08	14	02	42	13	55	21	21	23	22	16
17	18	08	07	51	03	06	14	14	21	31	23	19	17
18	17	52	07	28	03	29	14	33	21	40	23	16	18
19	17	35	07	05	03	52	14	51	21	49	23	13	19
20	17	18	06	42	04	16	15	09	21	58	23	09	20
21	17	01	06	19	04	39	15	27	22	06	23	05	21
22	16	44	05	56	05	02	15	45	22	14	23	00	22
23	16	26	05	33	05	25	16	03	22	22	22	55	23
24	16	08	05	10	05	48	16	20	22	29	22	50	24
25	15	50	04	46	06	11	16	37	22	36	22	44	25
26	15	32	04	23	06	33	16	53	22	42	22	37	26
27	15	13	03	59	06	56	17	10	22	48	22	30	27
28	14	54	03	36	07	18	17	26	22	54	22	23	28
29	14	35			07	41	17	41	22	59	22	16	29
30	14	16			08	03	17	57	23	04	22	08	30
31	13	56			08	25			23	08			31

1733, 1737, 1741, 1745, (*each being the first after Leap-Year.*)

Days.	July. N.		Aug. N.		Sep. N. *		Octob. S.		Nov. S.		Decem. S.		Days.
	°	′	°	′	°	′	°	′	°	′	°	′	
1	22	00	14	58	04	08	07	30	17	48	23	09	1
2	21	51	14	40	03	45	07	52	18	04	23	13	2
3	21	42	14	22	03	22	08	15	18	20	23	17	3
4	21	33	14	03	02	58	08	37	18	36	23	20	4
5	21	23	13	44	02	35	08	59	18	51	23	23	5
6	21	13	13	25	02	12	09	21	19	06	23	25	6
7	21	03	13	05	01	49	09	43	19	20	23	27	7
8	20	52	12	46	01	25	10	05	19	34	23	28	8
9	20	41	12	26	01	02	10	27	19	48	23	29	9
10	20	29	12	06	00	39	10	48	20	01	23	29	10
11	20	17	11	46	00	15	11	10	20	14	23	29	11
12	20	05	11	26	S	08	11	31	20	27	23	28	12
13	19	53	11	05	00	32	11	52	20	39	23	27	13
14	19	40	10	44	00	55	12	13	20	51	23	26	14
15	19	27	10	24	01	19	12	33	21	02	23	24	15
16	19	14	10	03	01	42	12	54	21	13	23	21	16
17	19	00	09	41	02	06	13	14	21	24	23	18	17
18	18	46	09	20	02	29	13	34	21	34	23	15	18
19	18	31	08	58	02	53	13	54	21	44	23	11	19
20	18	17	08	37	03	16	14	13	21	54	23	07	20
21	18	02	08	15	03	39	14	33	22	03	23	02	21
22	17	46	07	53	04	03	14	52	22	11	22	57	22
23	17	31	07	31	04	26	15	11	22	20	22	51	23
24	17	15	07	09	04	49	15	29	22	27	22	45	24
25	16	59	06	47	05	12	15	48	22	34	22	38	25
26	16	42	06	24	05	35	16	06	22	41	22	31	26
27	16	26	06	02	05	58	16	24	22	48	22	24	27
28	16	09	05	39	06	21	16	41	22	54	22	16	28
29	15	51	05	16	06	44	16	58	22	59	22	07	29
30	15	34	04	54	07	07	17	15	23	04	21	58	30
31	15	16	04	31			17	32			21	49	31

A TABLE *of the* Sun's *Declination for the Years*

Days.	Jan. S. °	′	Feb. S. °	′	March. S. * °	′	April. N. °	′	May. N. °	′	June. N. °	′	Days.
1	21	37	13	36	03	12	08	47	18	12	23	12	1
2	21	27	13	16	02	49	09	08	18	27	23	15	2
3	21	16	12	56	02	25	09	30	18	42	23	18	3
4	21	05	12	35	02	01	09	51	18	56	23	21	4
5	20	54	12	14	01	37	10	13	19	10	23	23	5
6	20	42	11	53	01	14	10	34	19	23	23	25	6
7	20	30	11	32	00	50	10	55	19	37	23	27	7
8	20	17	11	11	00	26	11	16	19	50	23	28	8
9	20	04	10	49	00	03	11	39	20	03	23	29	9
10	19	51	10	27	N	21	11	57	20	15	23	29	10
11	19	37	10	05	00	44	12	17	20	27	23	29	11
12	19	23	09	43	01	08	12	39	20	38	23	28	12
13	19	09	09	21	01	32	12	57	20	49	23	27	13
14	18	54	08	59	01	55	13	16	21	00	23	26	14
15	18	39	08	37	02	19	13	36	21	11	23	24	15
16	18	24	08	14	02	42	13	55	21	21	23	22	16
17	18	08	07	51	03	06	14	14	21	31	23	19	17
18	17	52	07	28	03	29	14	33	21	40	23	16	18
19	17	35	07	05	03	52	14	51	21	49	23	13	19
20	17	18	06	42	04	16	15	09	21	58	23	09	20
21	17	01	06	19	04	39	15	27	22	06	23	05	21
22	16	44	05	56	05	02	15	45	22	14	23	00	22
23	16	26	05	33	05	25	16	03	22	22	22	55	23
24	16	08	05	10	05	48	16	20	22	29	22	50	24
25	15	50	04	46	06	11	16	37	22	36	22	44	25
26	15	32	04	23	06	33	16	53	22	42	22	37	26
27	15	13	03	59	06	56	17	10	22	48	22	30	27
28	14	54	03	36	07	18	17	26	22	54	22	23	28
29	14	35			07	41	17	41	22	59	22	16	29
30	14	16			08	03	17	57	23	04	22	08	30
31	13	56			08	25			23	08			31

1733, 1737, 1741, 1745, *(each being the first after Leap-Year.)*

Days.	July. N. °	′	Aug. N. °	′	Sep. N. * °	′	Octob. S. °	′	Nov. S. °	′	Decem. S. °	′	Days.
1	22	00	14	58	04	08	07	30	17	48	23	09	1
2	21	51	14	40	03	45	07	52	18	04	23	13	2
3	21	42	14	22	03	22	08	15	18	20	23	17	3
4	21	33	14	03	02	58	08	37	18	36	23	20	4
5	21	23	13	44	02	35	08	59	18	51	23	23	5
6	21	13	13	25	02	12	09	21	19	06	23	25	6
7	21	03	13	05	01	49	09	43	19	20	23	27	7
8	20	52	12	46	01	25	10	05	19	34	23	28	8
9	20	41	12	26	01	02	10	27	19	48	23	29	9
10	20	29	12	06	00	39	10	48	20	01	23	29	10
11	20	17	11	46	00	15	11	10	20	14	23	29	11
12	20	05	11	26	S	08	11	31	20	27	23	28	12
13	19	53	11	05	00	32	11	52	20	39	23	27	13
14	19	40	10	44	00	55	12	13	20	51	23	26	14
15	19	27	10	24	01	19	12	33	21	02	23	24	15
16	19	14	10	03	01	42	12	54	21	13	23	21	16
17	19	00	09	41	02	06	13	14	21	24	23	18	17
18	18	46	09	20	02	29	13	34	21	34	23	15	18
19	18	31	08	58	02	53	13	54	21	44	23	11	19
20	18	17	08	37	03	16	14	13	21	54	23	07	20
21	18	02	08	15	03	39	14	33	22	03	23	02	21
22	17	46	07	53	04	03	14	52	22	11	22	57	22
23	17	31	07	31	04	26	15	11	22	20	22	51	23
24	17	15	07	09	04	49	15	29	22	27	22	45	24
25	16	59	06	47	05	12	15	48	22	34	22	38	25
26	16	42	06	24	05	35	16	06	22	41	22	31	26
27	16	26	06	02	05	58	16	24	22	48	22	24	27
28	16	09	05	39	06	21	16	41	22	54	22	16	28
29	15	51	05	16	06	44	16	58	22	59	22	07	29
30	15	34	04	54	07	07	17	15	23	04	21	58	30
31	15	16	04	31			17	32			21	49	31

A TABLE *of the* Sun's *Declination for the Years*

Days.	Jan. S. °	′	Feb. S. °	′	March. S. °	′	April. N. °	′	May. N. °	′	June. N. °	′	Days.
1	21	39	13	40	03	18	08	41	18	08	23	11	1
2	21	29	13	20	02	54	09	03	18	23	23	15	2
3	21	19	13	00	02	31	09	25	18	38	23	18	3
4	21	08	12	39	02	07	09	46	18	52	23	21	4
5	20	57	12	19	01	43	10	08	19	06	23	23	5
6	20	45	11	58	01	20	10	29	19	20	23	25	6
7	20	33	11	37	00	56	10	50	19	34	23	27	7
8	20	20	11	15	00	32	11	11	19	47	23	28	8
9	20	07	10	54	00	09	11	31	19	59	23	29	9
10	19	54	10	32	N	14	11	52	20	12	23	29	10
11	19	41	10	10	00	38	12	12	20	24	23	29	11
12	19	27	09	48	01	02	12	32	20	36	23	28	12
13	19	12	09	26	01	26	12	52	20	47	23	27	13
14	18	58	09	04	01	49	13	12	20	58	23	26	14
15	18	43	08	42	02	13	13	31	21	08	23	24	15
16	18	27	08	19	02	36	13	50	21	19	23	22	16
17	18	11	07	57	03	00	14	09	21	29	23	20	17
18	17	55	07	34	03	43	14	28	21	38	23	17	18
19	17	39	07	11	03	47	14	47	21	47	23	13	19
20	17	22	06	48	04	10	15	05	21	56	23	10	20
21	17	05	06	[illegible]5	04	33	15	23	22	05	23	06	21
22	16	48	06	02	04	56	15	41	22	13	23	01	22
23	16	31	05	39	05	19	15	58	22	20	22	56	23
24	16	13	05	15	05	42	16	15	22	27	22	51	24
25	15	55	04	52	06	05	16	32	22	34	22	45	25
26	15	36	04	29	06	28	16	49	22	41	22	39	26
27	15	18	04	05	06	50	17	05	22	47	22	32	27
28	14	58	03	42	07	13	17	22	22	53	22	25	28
29	14	39			07	35	17	38	22	58	22	18	29
30	14	20			07	57	17	53	23	03	22	10	30
31	14	00			08	19			23	07			31

1730, 1734, 1738, 1742, (*each being the second after Leap-Year.*)

Days	July. N. °	July. N. '	Aug. N. °	Aug. N. '	Sept. N. * °	Sept. N. * '	Octob. S. °	Octob. S. '	Nov. S. °	Nov. S. '	Decem. S. °	Decem. S. '	Days
1	22	02	15	02	04	13	07	24	17	44	23	08	1
2	21	53	14	44	03	50	07	47	18	00	23	12	2
3	21	44	14	26	03	27	08	09	18	16	23	16	3
4	21	35	14	07	03	04	08	32	18	32	23	19	4
5	21	26	13	48	02	41	08	54	18	47	23	22	5
6	21	16	13	29	02	17	09	16	19	02	23	24	6
7	21	06	13	10	01	54	09	38	19	17	23	26	7
8	20	55	12	51	01	31	10	00	19	31	23	27	8
9	20	44	12	31	01	07	10	21	19	45	23	28	9
10	20	33	12	11	00	44	10	43	19	58	23	29	10
11	20	21	11	51	00	21	11	04	20	11	23	29	11
12	20	09	11	31	S	03	11	26	20	24	23	28	12
13	19	57	11	19	00	26	11	47	20	36	23	27	13
14	19	44	10	49	00	50	12	08	20	48	23	26	14
15	19	31	10	28	01	13	12	28	21	00	23	24	15
16	19	18	10	07	01	37	12	49	21	11	23	22	16
17	19	04	09	46	02	00	13	09	21	22	23	19	17
18	18	50	09	25	02	23	13	29	21	32	23	16	18
19	18	35	09	04	02	47	13	49	21	42	23	12	19
20	18	20	08	42	03	10	14	09	21	51	23	08	20
21	18	05	08	20	03	34	14	28	22	00	23	03	21
22	17	51	07	58	03	57	14	47	22	09	22	58	22
23	17	35	07	36	04	20	15	06	22	17	22	52	23
24	17	19	07	14	04	44	15	25	22	25	22	46	24
25	17	03	06	52	05	07	15	43	22	33	22	40	25
26	16	46	06	30	05	30	16	01	22	40	22	33	26
27	16	30	06	07	05	53	16	19	22	46	22	25	27
28	16	13	05	44	06	16	16	37	22	52	22	17	28
29	15	56	05	22	06	39	16	54	22	58	22	09	29
30	15	39	04	59	07	02	17	11	23	03	22	00	30
31	15	21	04	36			17	28			21	51	31

A TABLE of the Sun's Declination for the Years

Days	Jan. S. °	'	Feb. S. °	'	March. S. °	'	April. N. °	'	May. N. °	'	June. N. °	'	Days
1	21	48	13	45	03	24	08	36	18	05	23	10	1
2	21	32	13	25	03	00	08	58	18	26	23	14	2
3	21	21	13	05	02	36	09	17	18	35	23	17	3
4	21	10	12	44	02	13	09	39	18	49	23	20	4
5	20	59	12	24	01	49	10	03	19	03	23	23	5
6	20	48	12	03	01	25	10	24	19	15	23	25	6
7	20	36	11	42	01	02	10	45	19	29	23	26	7
8	20	23	11	21	00	38	11	06	19	43	23	27	8
9	20	10	10	59	00	14	11	27	19	56	23	28	9
10	19	57	10	38	N	09	11	47	20	09	23	29	10
11	19	44	10	16	00	33	12	07	20	21	23	29	11
12	19	30	09	54	00	56	12	27	20	33	23	29	12
13	19	16	09	32	01	20	12	47	20	44	23	28	13
14	19	01	09	10	01	44	13	07	20	55	23	27	14
15	18	46	08	47	02	07	13	26	21	06	23	25	15
16	18	31	08	25	02	31	13	46	21	16	23	23	16
17	18	15	08	02	02	54	14	05	21	26	23	21	17
18	17	59	07	39	03	18	14	24	21	36	23	18	18
19	17	43	07	17	03	41	14	42	21	45	23	14	19
20	17	26	06	54	04	04	14	59	21	54	23	11	20
21	17	09	06	31	04	27	15	19	22	03	23	07	21
22	16	52	06	08	04	51	15	37	22	11	23	02	22
23	16	35	05	44	05	14	15	54	22	18	22	57	23
24	16	17	05	21	05	37	16	11	22	26	22	52	24
25	15	59	04	58	05	59	16	28	22	33	22	46	25
26	15	41	04	34	06	22	16	45	22	39	22	40	26
27	15	22	04	11	06	45	17	02	22	45	22	34	27
28	15	03	03	47	07	07	17	18	22	51	22	27	28
29	14	44			07	30	17	34	22	56	22	20	29
30	14	25			07	52	17	50	23	01	22	12	30
31	14	05			08	14			23	06			31

1731, 1735, 1739, 1743, (*each being the third after Leap-Year.*)

Days.	July. N. °	'	Aug. N. °	'	Sep. N.* °	'	Octob. S. °	'	Nov. S. °	'	Decem. S. °	'	Days.
1	22	04	15	07	04	19	07	19	17	41	23	07	1
2	21	55	14	49	03	56	07	41	17	57	23	11	2
3	21	47	14	30	03	33	08	04	18	13	23	15	3
4	21	38	14	12	03	10	08	26	18	28	23	18	4
5	21	28	13	53	02	46	08	58	18	43	23	21	5
6	21	18	13	34	02	23	09	11	18	58	23	24	6
7	21	08	13	15	02	00	09	33	19	13	23	26	7
8	20	57	12	55	01	36	09	54	19	27	23	27	8
9	20	46	12	36	01	13	10	16	19	41	23	28	9
10	20	35	12	16	00	50	10	38	19	55	23	29	10
11	20	23	11	56	00	26	10	59	20	08	23	29	11
12	20	13	11	35	00	03	11	20	20	21	23	29	12
13	20	01	11	15	S	20	11	42	20	33	23	28	13
14	19	47	10	54	00	44	12	03	20	45	23	27	14
15	19	34	10	34	01	07	12	23	20	57	23	25	15
16	19	20	10	13	01	31	12	44	21	08	23	23	16
17	19	07	09	51	01	54	13	04	21	19	23	20	17
18	18	53	09	30	02	18	13	24	21	30	23	17	18
19	18	38	09	09	02	41	13	44	21	40	23	13	19
20	18	24	08	47	03	05	14	04	21	49	23	09	20
21	18	09	08	25	03	28	14	23	21	58	23	04	21
22	17	54	08	04	03	51	14	42	22	07	22	59	22
23	17	38	07	42	04	15	15	01	22	16	22	54	23
24	17	23	07	20	04	38	15	20	22	24	22	48	24
25	17	07	06	57	05	01	15	39	22	31	22	42	25
26	16	50	06	35	05	24	15	57	22	38	22	35	26
27	16	34	06	12	05	47	16	15	22	45	22	27	27
28	16	17	05	50	06	10	16	33	22	51	22	20	28
29	16	00	05	27	06	33	16	50	22	57	22	12	29
30	15	42	05	05	06	56	17	07	23	02	22	03	20
31	15	25	04	42			17	24			21	54	31

A TABLE *of the* Sun's *Declination for the Years*

Days	Jan. S. °	'	Feb. S. °	'	March. S. * °	'	April. N. °	'	May. N. °	'	June. N. °	'	Days
1	21	44	13	50	03	06	08	53	18	16	23	13	1
2	21	34	13	30	02	42	09	14	18	31	23	16	2
3	21	24	13	10	02	19	09	36	18	46	23	19	3
4	21	13	12	49	01	55	09	57	19	00	23	22	4
5	21	02	12	29	01	31	10	19	19	14	23	24	5
6	20	51	12	08	01	08	10	40	19	27	23	26	6
7	20	39	11	47	00	44	11	01	19	40	23	27	7
8	20	27	11	26	00	20	11	21	19	53	23	28	8
9	20	14	11	04	N	03	11	42	20	06	23	29	9
10	20	01	10	43	00	27	12	02	20	18	23	29	10
11	19	47	10	21	00	51	12	23	20	30	23	29	11
12	19	35	09	59	01	14	12	40	20	41	23	28	12
13	19	19	09	37	01	38	13	02	20	52	23	27	13
14	19	05	09	15	02	02	13	22	21	03	23	25	14
15	18	50	08	53	02	25	13	41	21	14	23	23	15
16	18	35	08	30	02	49	14	00	21	24	23	21	16
17	18	19	08	08	03	12	14	19	21	34	23	18	17
18	18	03	07	45	03	35	14	38	21	43	23	15	18
19	17	47	07	22	03	59	14	56	21	52	23	12	19
20	17	30	06	59	04	22	15	14	22	00	23	08	20
21	17	13	06	36	04	45	15	32	22	09	23	04	21
22	16	56	06	13	05	08	15	50	22	17	22	59	22
23	16	39	05	50	05	31	16	07	22	24	22	54	23
24	16	21	05	27	05	54	16	24	22	31	22	48	24
25	16	03	05	03	06	17	16	41	22	38	22	42	25
26	15	45	04	40	06	39	16	58	22	44	22	35	26
27	15	27	04	17	07	02	17	14	22	50	22	29	27
28	15	08	03	53	07	24	17	30	22	55	22	22	28
29	14	49	03	29	07	47	17	46	23	00	22	14	29
30	14	29			08	09	18	01	23	05	22	06	30
31	14	10			08	31			23	09			31

1732, 1736, 1740, 1744, (*being Leap-Years.*)

Days.	July. N.		Aug. N.		Sept. N.*		Octob. S.		Nov. S.		Decem. S.		Days.
	°	'	°	'	°	'	°	'	°	'	°	'	
1	21	58	14	53	04	01	07	36	17	53	23	10	1
2	21	49	14	35	03	38	07	58	18	09	23	14	2
3	21	40	14	16	03	15	08	21	18	25	23	17	3
4	21	31	13	58	02	52	08	43	18	40	23	20	4
5	21	21	13	39	02	29	09	05	18	55	23	23	5
6	21	11	13	19	02	05	09	27	19	10	23	25	6
7	21	00	13	00	01	42	09	49	19	24	23	27	7
8	20	49	12	40	01	19	10	11	19	38	23	28	8
9	20	38	12	21	00	55	10	33	19	52	23	29	9
10	20	27	12	01	00	32	10	54	20	05	23	29	10
11	20	15	11	40	00	08	11	15	20	18	23	29	11
12	20	02	11	20	S	15	11	37	20	30	23	28	12
13	19	50	10	59	00	38	11	58	20	42	23	27	13
14	19	37	10	39	01	02	12	18	20	54	23	25	14
15	19	24	10	18	01	25	12	39	21	05	23	23	15
16	19	10	09	57	01	49	12	59	21	16	23	20	16
17	18	56	09	35	02	12	13	19	21	27	23	17	17
18	18	42	09	14	02	36	13	39	21	37	23	14	18
19	18	27	08	52	02	59	13	59	21	47	23	10	19
20	18	12	08	31	03	22	14	19	21	56	23	05	20
21	17	57	08	09	03	46	14	38	22	05	23	00	21
22	17	42	07	47	04	09	14	57	22	14	22	55	22
23	17	26	07	25	04	32	15	16	22	22	22	49	23
24	17	10	07	03	04	56	15	34	22	29	22	43	24
25	16	54	06	40	05	19	15	53	22	36	22	36	25
26	16	38	06	18	05	42	16	11	22	43	22	29	26
27	16	21	05	55	06	05	16	29	22	49	22	21	27
28	16	04	05	33	06	28	16	46	22	55	22	13	28
29	15	47	05	10	06	51	17	03	23	01	22	05	29
30	15	29	04	47	07	13	17	20	23	06	21	56	30
31	15	11	04	24			17	37			21	46	31

A Table *of the Variation of the Sun's Declination to every* 15 *Degrees of Longitude from the Meridian of* London.

Degrees of Longitude from the Meridian of London.

Daily Variat. Min.	*D.* 15 *M*	*D.* 30 *M*	*D.* 45 *M*	*D.* 60 *M*	*D.* 75 *M*	*D.* 90 *M*	*Deg.* 105 *Min.*	*Deg.* 120 *Min.*	*Deg.* 135 *Min.*	*Deg.* 150 *Min.*	*Deg.* 165 *Min.*	*Deg.* 180 *Min.*
2	00	00	00	00	00	00	01	01	01	01	01	01
3	00	00	00	00	01	01	01	01	01	01	01	01
4	00	00	00	01	01	01	01	02	02	02	02	02
5	00	00	01	01	01	01	01	02	02	02	02	02
6	00	00	01	01	01	01	02	02	02	02	03	03
7	00	01	01	01	01	02	02	03	03	03	03	03
8	00	01	01	01	02	02	02	03	03	03	04	04
9	00	01	01	01	02	02	03	03	03	04	04	04
10	00	01	01	02	02	02	03	03	04	04	05	05
11	00	01	01	02	02	03	03	04	04	05	05	05
12	00	01	01	02	02	03	03	04	04	05	05	06
13	01	01	02	02	03	03	04	04	05	05	06	06
14	01	01	02	02	03	03	04	05	05	06	06	06
15	01	01	02	02	03	04	04	05	06	06	07	07
16	01	01	02	03	03	04	05	05	06	07	07	07
17	01	01	02	03	04	04	05	06	06	07	08	08
18	01	01	02	03	04	04	05	06	07	07	08	09
19	01	02	02	03	04	05	06	06	07	08	09	09
20	01	02	02	03	04	05	06	06	07	08	09	10
21	01	02	03	03	04	05	06	07	08	09	10	10
22	01	02	03	04	05	05	06	07	08	09	10	11
23	01	02	03	04	05	06	07	08	09	10	11	11
24	01	02	03	04	05	06	07	08	09	10	11	12

A TABLE *of the Declinations of some of the most Principal fix'd Stars.*

Stars Names	Declin.		Den.
SCHEDAR, in the Breast of *Cassiopeia* —	55	02	N
The bright Star of *Aries* — — —	22	08	N
Algol, the Head of *Medusa* — — —	39	52	N
Aldebaran, the *Bull's Eye* — — —	15	55	N
The *Goat* Star *Capella* — — —	45	41	N
The Heart of *Hydra* — — —	07	29	S
The Middlemost Star in *Orion*'s Belt — —	01	25	S
The Dog Star *Syrius* — — — —	16	21	S
Procyon, or the little Dog Star — — —	05	54	N
Castor, or the Head of the Northermost Twin —	32	27	N
Pollux. or the Head of the Southermost Twin —	28	39	N
Regulus, the *Lyon*'s Heart — — —	13	17	N
Deneb, the *Lyon*'s Tail - - - - -	16	06	N
The *Virgin's Spike* - - - - -	09	43	S
Antares, the *Scorpion*'s Heart - - -	25	47	S
The Southermost of the two preceeding Stars in the Square of the *Great Bear* —	57	51	N
The Northermost of the same Two - -	63	13	N
The Southermost in the two following Stars in the Square of the *Great Bear* —	55	13	N
The Northermost of the same Two - -	58	34	N
The First in the Tail of the *Great Bear* - -	57	28	N
The Second in the Tail - - - - - -	56	22	N
The last of the Three in the Tail - - - -	50	42	N
Arcturus - - - - - - - - - - -	20	39	N
Lyra, the bright Star in the *Harp* - - -	38	33	N
Altair, the bright Star in the *Eagle* - -	08	10	N
The preceeding of the two Middlemost in the *Cross*	57	11	S
The Northern Foot of the *Cross* - - - -	55	30	S
The Southern Foot of the *Cross* - - - -	61	31	S
The Eastermost of the four Stars in the *Cross* -	58	06	S

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